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# Christmas Tree Pest Manual

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# Christmas Tree Pest Manual

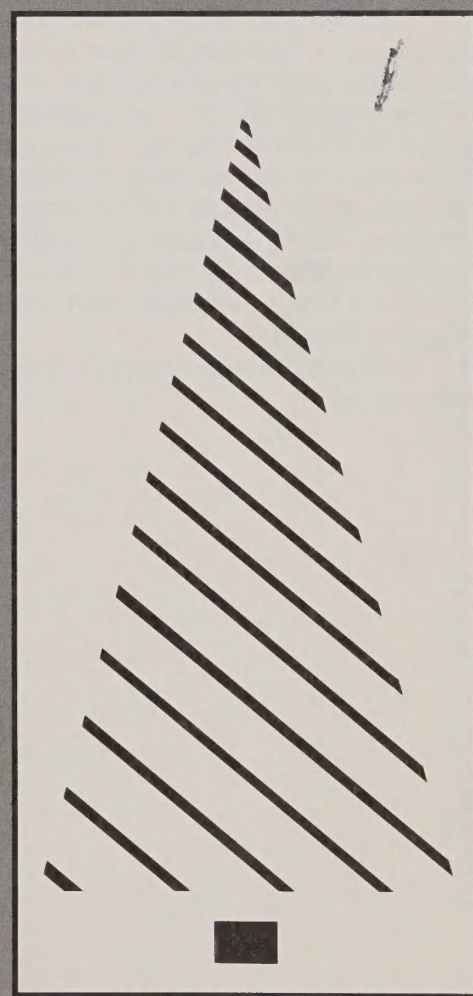
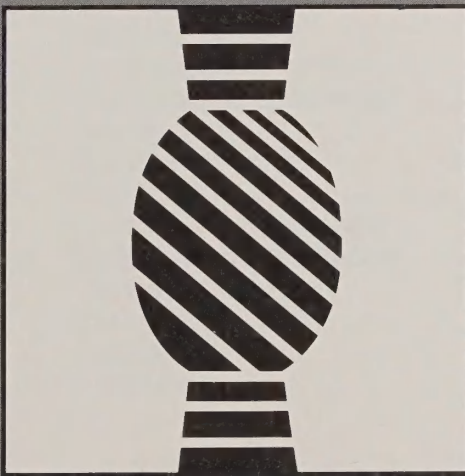
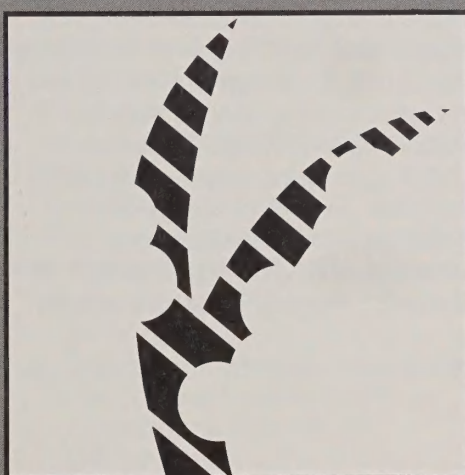
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## Acknowledgements

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This manual is part of a Forest Service technology transfer plan designed to get research findings "off the shelf" and into the hands of people who need them. A team of scientists and pest specialists worked with a writer/editor to summarize and compile more than 10 years of research on Christmas tree pests and their control. Much of this research was conducted at the North Central Forest Experiment Station, headquartered in St. Paul, Minnesota.

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Unless otherwise noted, all photographs were taken by Forest Service employees.



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This manual can help you identify and control damaging Christmas tree pests in the north-central region of the United States. Most of the information also applies to the Northeastern States and to the southern portions of the Canadian Provinces that border these States.

You do not have to be a pest specialist to use this information; we wrote the manual in everyday language so that anyone with an interest in Christmas trees could read and understand it. Because it is meant to be a tool and not a textbook, we included only what you need to know to solve pest problems in your nursery or plantation.

In addition to the 70 illustrated pest profiles, you will find plenty of practical advice on:

- how to look for and recognize potential pests
- how to select, plant, and care for trees so they are less likely to be damaged by pests
- how to keep pest numbers at harmless levels

These techniques work to discourage pests and prevent them from causing serious damage. We encourage you to read the opening sections of the manual long before pests have a chance to build up on your trees.

Carry the manual with you when you inspect your nursery or plantation. If you notice anything out of the ordinary, turn to the "How to Identify and Control Pests" section beginning on p. 21. This section can help you diagnose tree injury in much the

same way that a doctor diagnoses an illness—by working backwards from the symptoms to the cause. All you need to know is the tree species injured and what the injury looks like. Then simply follow these six steps:

**1. *Decide what kind of injury your tree has:***

Needle discoloration  
Needle feeding  
Shoot/branch injury  
Shoot/branch galls  
Dead tree and stem/root injury  
Turn to the appropriate section in the manual. Check your selection by comparing the injury with the description on the first page of the section.

**2. *Leaf through that section, checking for your species on the lower, outside corners of the pages.***

These pages contain photos and descriptions of the pests that attack the species indicated.

**3. *Now, sorting through the pests that attack your species, find the photos that most closely match the damage you see on your trees.***

When you are pretty sure you have found the culprit, double-check against the "pests that cause similar symptoms" listed at the end of each pest description. If you have any doubts about identification, you can send samples of the pest and the injured tree parts to your local pest specialist (see "How to Submit Material for Identification," p. 85).

**4. *Finally, review the symptoms and signs listed under "Look For."*** You can identify most pests by the clues they leave or the kind of injury they cause. These symptoms and signs

are highlighted in italic type and grouped by the time of year they are most likely to be seen (timing may vary with geographic location). Features visible year-round are listed first, without a calendar heading. Pests are also described in terms of their importance, biology, and other characteristics.

**5. *Decide whether control is needed.*** The "Monitoring" section for each pest can help you measure the amount of pest activity on your trees and help you decide how much, if any, control is needed. Before you begin any pest control treatment, ask yourself whether the value of the benefits will exceed the cost of the treatment. In short, will it pay? You may want to contact a pest specialist to help you predict and estimate damage. (See "Where to Get Help," p. 85.)

**6. *Select control methods.*** In the "Control" section for each pest, recommended management and control techniques are divided into two categories: "This Crop" and "Next Crop." "This Crop" controls can help prevent or reduce pest problems on *established* seedlings and trees—those now growing in your nursery or plantation. "Next Crop" controls can help you guard against pest problems on *new* stock next time you plant.



## What is a Pest?

A pest is something that gets in the way of what people want to do. In the Christmas tree business, the goal is to harvest healthy-looking, high-quality trees. Insects, diseases, animals, birds, and environmental factors that destroy or damage those trees are therefore considered pests. In their natural settings, these "pests" may be relatively harmless, but in intensively managed nurseries and plantations, they can be undesirable indeed.

The pests in this manual fall into four groups:

- Insects
- Fungi and nematodes
- Birds and mammals
- Environmental factors

The more you know about them, the better able you are to solve pest problems in your nursery or plantation. This section briefly describes how these pests grow, reproduce, and affect Christmas trees. For more information about the biology or characteristics of a given species, see the "How To Identify and Control Pests" section.

### Insects

Insects and their close relatives, mites, are the most common pests of Christmas trees. This manual lists the major ones, but there are hundreds of others that may do minor injury to your trees.

When abundant, insects can cause costly injury at various times in a tree's growing cycle. Seedlings and young trees are particularly vulnerable because it takes only a few insects to injure or kill them. However, older trees may also be injured when insects are numerous.

Insects damage Christmas trees in many ways. They can chew on or inside the needles or tunnel inside the shoots and trunk. Some insects suck sap from the needles, buds, or stems, weakening or killing the tree. Others cause swellings, or "galls" to form, and a few spread disease organisms directly or indirectly while feeding.

Insects are one of those unique groups of organisms that change form at least once during their lifetime. This is important to you as a

Christmas tree grower because different insect forms cause different kinds of damage. For example, the larval form of one species may cause serious injury to a certain tree species while the adult form is perfectly harmless.

The simplest kind of change, or "metamorphosis," starts when a "nymph" (a miniature copy of the adult) hatches from an egg and then sheds its skin, or "molts," several times before maturing into an adult. Pests that have this simple metamorphosis include grasshoppers, thrips, spittlebugs, aphids, and mites.

More complex (or "complete") metamorphosis proceeds from the egg through "larval" and "pupal" stages (each greatly different in form from the previous one) before the adult finally emerges. Common insects with complete metamorphosis are beetles, weevils, moths, midges, and sawflies.

In both cases, the adults mate, produce eggs, and start the process over again.



*Four stages in the life of a sawfly (l. to r.): eggs, larva, pupa, and adult.*

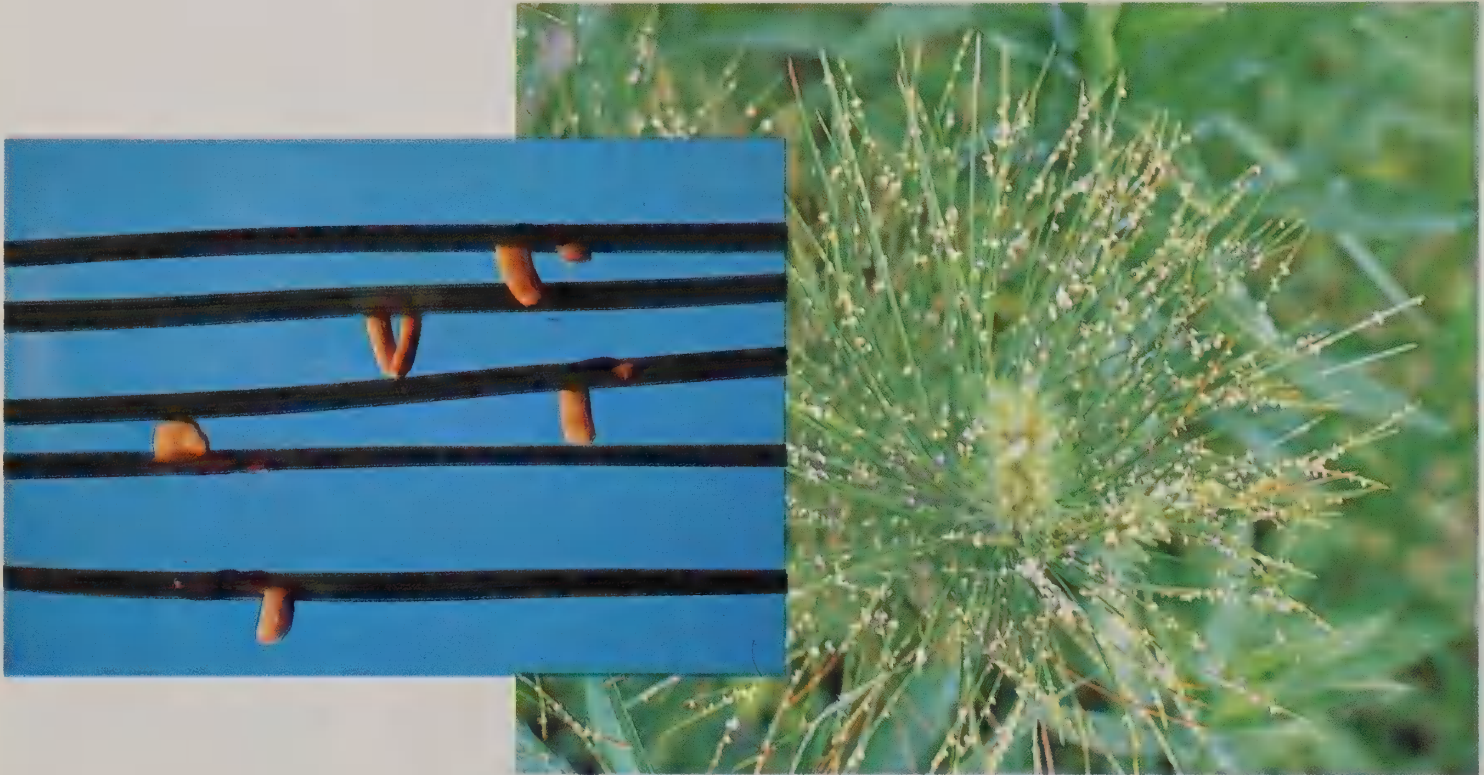
### Fungi and Nematodes

Fungi and nematodes cause disease in trees. A diseased tree may develop abnormal swellings, galls, or leaf curls. Other evidences of disease are discoloration, early needle drop, crooks, wilting, and cankers.

Mushrooms, molds, and rusts belong to the largest group of organisms that cause disease—the fungi. These simple plants live on

other living organisms or in decaying organic material because they do not have food-making chlorophyll of their own. Fungi reproduce by means of spores—the fungal equivalent of seeds. Spores spread the disease when moved—by wind, rain, or mechanical means—from one host to another. Transporting plants, plant parts, and soil from one area to another may also spread the disease.

Nematodes are members of a group of animals known as roundworms—long, wormlike animals tapered at both ends. Nematodes feed by puncturing tree cells with their hollow feeding tube and sucking out the cell contents. They hatch from eggs and pass through several larval stages when developing. Some nematodes that injure Christmas trees are carried from tree to tree by insects.



*Spore-filled fruiting bodies erupt from needles infected with pine needle rust.*



---

## Birds and Mammals

Some birds and mammals will also injure Christmas trees. Pine grosbeaks eat buds and yellow-bellied sapsuckers peck holes in tree stems. Although birds are usually minor pests, they can sometimes cause enough injury to degrade trees.

Deer nip shoots and occasionally degrade trees, but the mammals that do the worst damage are mice,

rabbits, and pocket gophers. All of these chew the bark of stems or roots and can readily kill your trees.

## Environmental Factors

Some environmental factors that can injure Christmas trees either directly or indirectly are poor soil, extremes of weather, and toxic chemicals such as air pollutants, pesticides, salts, and excessive amounts of fertilizer. Disorders caused by these factors cannot be passed from one tree to another like diseases.



*White-tailed deer.*



*Snowshoe hare.*



*Yellow-bellied sapsucker.*



*Air pollutants can discolor needles and lower the value of Christmas trees.*



Pest control—or management, as it is now more properly called—begins before you plant your first tree and extends through harvest time. In fact, everything you do to your plantation, from selecting a species and preparing the site to cultivating, shearing, and beyond, has some bearing on pests.

For many years, pest “control” meant reaching for the pesticide sprayer anytime a spot or an insect appeared on a tree. Trying to kill every last pest was not only costly, but also environmentally reckless. Today, the goal is merely to reduce losses to a tolerable level by using a variety of control methods. Emphasis is on cultural and biological treatments, supplemented only when necessary by chemicals. Four general steps are involved.

### **Step 1. Plant the Right Species on the Right Site.**

#### ***Choosing Your Trees***

Ideally, the species you plant should grow well on your site, be somewhat resistant to pests, and give a good return on your investment. Other important traits are form, hardiness, growth rate, and color at harvest time. Scotch pine is popular because it has many favorable qualities, but several other pines, spruces, firs, and eastern redcedar should also be considered, especially if your site is better suited to them.

Because Scotch pine has been a favored Christmas-tree species over the years, many varieties have been developed to enhance certain genetic qualities. Some of these qualities have to do with resistance to pests. So, if you are planning to plant Scotch pine, check with local growers and extension agents for the pests most common to your area. Then use the following table to select a variety that is most resistant to those pests.



*Two varieties of Scotch pine after a severe Wisconsin winter. The long-needled variety (left) is more resistant to winter injury than the short-needled variety (right).*



Table 1. Resistance<sup>1/</sup> of major Scotch pine varieties to nine Christmas tree pests (1 = very low, 2 = low, 3 = moderate, 4 = high, 5 = very high)

Origin and varietal name/ short-needed(s) medium (m) long-needed (l)	Brown spot & Lophodermium needlecast	Eastern pine shoot borer	European pine sawfly	Pine gros- beak	Pine root collar weevil	Winter Injury <sup>2/</sup>	White pine weevil	Zimmer- man pine moth
<b>Northern Eurasia</b>								
Scandinavian (s)	—	3	4	1	3	5	2	3
Siberia (s)	—	3	4	3	3	5	3	2
Swedish (s)	—	4	4	1	4	5	5	5
Swedish (Riga) (m)	—	3	4	3	2	5	2	3
Ural Mountains(m)	—	3	5	3	3	5	1	1
Krasnoyarsk (m)	—	3	4	3	3	5	—	3
<b>Central Europe</b>								
Belgian (l)	3	3	2	4	2	5	2	1
Czechoslovakia (m)	3	3	3	4	2	5	3	2
East Anglia (l)	3	3	2	3	2	4	—	1
German (l)	3	3	3	—	2	4	—	—
Hungary (l)	3	2	2	5	2	5	1	3
Poland (m)	3	3	3	4	2	5	2	2
<b>West &amp; S. Eurasia</b>								
Greece (s)	2	2	3	3	4	5	2	4
Italian (m)	2	2	3	3	4	5	—	4
N. Italy (m)	2	—	4	—	4	4	—	—
Scotland (m)	2	2	3	2	4	<sup>3</sup> 4	—	2
S. French (s)	2	2	3	4	4	<sup>4</sup> 3	2	4
Spanish (s)	2	2	1	4	4	1	5	4
Turkey (l)	2	2	3	3	4	4	3	4
Yugoslavian (m)	2	2	3	3	4	5	2	4

<sup>1</sup>Resistance, as used here, means the ability of a particular variety of Scotch pine to withstand attack by a given pest.

<sup>2</sup>Injury for areas such as Minnesota, Wisconsin, and the Upper Peninsula of Michigan. Varieties not listed in table: Austrian Hills (l) (3); Finland (m) (5); French Pyrenees (s) (1); Romania (5); Russia (5); Wales (4).

<sup>3</sup>Specific Scottish names: Spey Valley (4); Scottish Highland (3).

<sup>4</sup>Specific French names: Auvergne Haute Loire (3); Lu Puy Province Mtn. Strain (3); Auvergne Lourdes Haute Loire (2); Auvergne St. Nizier de Formas (2); French-Green (2).

## Notes:

### *Preparing the Site*

Careful site preparation is another essential part of pest management. Poorly prepared planting sites put stress on trees, and stress invariably leads to pest problems.

If you are planting on a new site that has not had Christmas trees on it before, it is usually a good idea to cultivate or treat the site with herbicides to remove vegetation that may compete with the seedlings for light, water, or nutrients. Using herbicides in the fall of the year before planting will also leave dead vegetation on the site that will hold the soil and reduce erosion. By controlling weeds and grasses after planting, you can continue to keep competition down, reduce mammal habitat, increase air flow, and destroy alternate hosts—plants that certain insects and diseases live on for part of their lives.

Before planting on a site, you should consider potential pest problems. Are there pests on trees in nearby windbreaks or woodlots? If so, you may want to treat or remove these pest “reservoirs” before planting. If pests in the surrounding areas are difficult to manage, consider planting a tree species that can withstand injury or is resistant to the pests.

Before planting, send soil samples to your extension service or testing firm for analysis. They can tell you if fertilizer or soil treatments are needed to make your plantation more productive. You may even find out that your land needs too much work to make your venture worthwhile.

When replanting a harvested site, it is wise to remove or destroy residue, unsalable trees, and old stumps that might lure pests to the site.

### *Planting*

A little extra care at planting time will pay off in good survival and growth. Try to avoid planting on sites that are prone to frost or where soils are stony, coarse-textured, or otherwise unsuitable for trees. Such sites invite pest problems. Instead, give your seedlings a head start on good growth by choosing sites that are well matched to the growing needs of the species you have selected.

Spacing is also important. Although seedling suppliers and Christmas tree guides suggest planting 4'x4' or 4'x5', a better spacing is 5'x6' or 6'x6'. This extra space will give you fewer trees, but will also help reduce insect movement and disease spread. Extra-wide spacing and access strips (i.e., 1 or 2 unplanted rows) make shearing easier and allow more room for spray or harvesting equipment.

Plant your seedlings in up-and-down-hill rows rather than along the contours of the land. This increases air flow and drainage, allowing trees to dry quickly after rain with less chance of disease spread. It also pays to plant 3-or-4-year-old transplants if available. These plants are hardier and tend to take root faster and survive better than younger seedlings. When handling seedlings, keep the roots moist to ensure survival and ease transplanting shock.

As you plant, try to spread the roots out in the planting hole to prevent them from growing in a J-shaped curve. Roots grown this way are especially vulnerable to white grubs during the first and second seasons after planting. J-rooted trees also tend to be weak and unstable.

Place seedlings so that the root crown is at or slightly below the surface of the soil, at the same level it was in the nursery bed. Pine root collar weevils injure pines more readily when the root collar is more than 2 inches below the ground because an underground “collar” is available for them to girdle.



*Before replanting, destroy unsalable trees and old stumps that may harbor pests.*



## Step 2. Monitor for Pests

Despite your preventive efforts, insects, diseases, and other pests can still injure your seedlings and trees. So it pays to walk through your nursery or plantation on a regular basis, keeping track of tree condition, pest abundance, and damage. If you are observant, you can usually spot the symptoms and signs of distress before widespread damage occurs.

Inspecting, or *monitoring*, your trees can also help you:

- learn which species and varieties are most resistant to damage
- discover which organisms are pests and which ones are desirable
- anticipate and prevent pest damage
- gauge how much damage a tree can handle without a loss in grade
- decide whether control is needed
- judge the results of your management decisions.

It is good practice to inspect your trees weekly throughout the growing season and occasionally in winter.

Although most pests are active during the warmest season, some diseases do best in cool, moist weather, and birds and mammals do the most damage in winter when their normal food is scarce.

Monitoring should begin when your stock arrives from the nursery and continue until cutting. "Hitchhiking" nursery pests are particularly serious because even a few pests can destroy the small plants and quickly spread to other parts of your plantation. To be safe, keep careful records, buy locally-grown seedlings (if available), and ask your seedling supplier about guarantees and pest-free certificates.

It also pays to know something about the habits of pests you find on your trees. Certain pests, even when numerous, may not seriously damage a tree if it is large enough. For example, several thousand European pine sawflies can strip all the needles off a 5-foot pine, but because they eat only old needles, the tree is barely injured and recovers fully in 2 or 3 years. On the other hand, one or two Zimmerman

pine moth larvae can easily kill the same 5-foot pine in one season. Naturally, the more "significant" the pest, the more vigilant your monitoring should be. If your first inspection reveals no serious threats, keep at it. The situation can change in a hurry.

To keep abreast of local pest conditions, check into the computer-based regional pest monitoring programs now available for Christmas tree growers. These programs provide historical as well as current information on pest problems. A network of volunteers in each State constantly updates the information by reporting observations about stand conditions, weather, pest outbreaks, etc.

Your participation in the program will help you and the Christmas tree industry. For more information, contact your State pest survey coordinating committee through the USDA APHIS office in your State or region, your State Department of Agriculture, State Department of Natural Resources, or your cooperative extension agent.



*Inspecting your trees regularly can help you stay a step ahead of pest problems.*



### Step 3. Use a Combination of Controls

When faced with a serious pest buildup, your best bet may be a combination of simple, low-key treatments rather than a single, drastic action. And, as mentioned before, although chemical control may be used to combat pests, it should only be used as a last resort. In this manual, you will find many good alternatives and supplements to pesticides. Not only are they safer, but in many cases, their effect outlasts the "quick-fix" of chemical control.

The strategies suggested here will not completely eliminate pests from your nursery or plantation. Experts agree there is only one way to wipe out pests: remove the Christmas trees they feed on! Instead, these strategies work to

bring pest populations down to acceptable levels and keep them there. An *acceptable level* merely means the trees will not be dead or degraded at the time of harvest. You can reach this level by practicing prevention and some combination of manual, mechanical, biological, cultural, legal, and chemical control methods.

Most of the methods presented here have been found to be successful. However, a few of these have not yet been extensively tested, so you may wish to try them and see if they work for you. One treatment may work well in one area and not as well in another, so continue trying new treatments or seek help if you have trouble managing a pest. (See "Where to Get Help," p. 85.)

### Manual and Mechanical Control

Hand methods or mechanical devices can be used in small plantings to control pests or to make the environment unsuitable for their survival. For instance, insects in low numbers can sometimes be hand picked or knocked off the tree and stepped on. Fresh pieces of tree stem can be set out in the plantation to catch certain weevils. Predator calls recorded on tape can be broadcast in the field to drive off bothersome birds. Sometimes, these simple controls are all that is needed to discourage costly pest damage.



*Clipping galls that house cooley spruce gall aphid nymphs is an effective form of manual control.*



*Even healthy plantations contain pests. Keep pests at harmless levels by using a combination of controls.*



## Biological Control

One of the best defensive plays in pest management mimics the "checks and balances" system that keeps natural populations on an even keel. Biological control is the deliberate use of natural enemies, such as predators, parasites, and diseases, to regulate pest populations.

Once natural enemies become permanent "residents," pests are less likely to increase to damaging proportions. The lasting nature of biological control makes it relatively inexpensive as well as environmentally safe.

To put this "checks and balances" system to work, you can either introduce beneficial organisms into your nursery or plantation or simply encourage those that are already in place. The "good guys" include lady bugs, which devour aphids and scales by the hundreds, and lacewing flies and spiders, which

also feed on the enemies of Christmas trees. Parasitic wasps check pest numbers by laying their eggs inside harmful insects. And there are many other parasites and "good" diseases that can also weaken or kill Christmas tree pests.

You can attract beneficial predators and parasites to your trees by leaving edge rows and/or occasional strips or clumps of certain flowering weeds as a pollen source. Adult parasites of many insects need pollen for food and will search out pests in your plantation if a nearby pollen source is plentiful. For instance, leaving strips of wild carrot (Queen Anne's lace) will provide food for parasites of the European pine shoot moth.

Some of these beneficial predators and parasites can be bought commercially. For example, a disease organism called *Bacillus thuringiensis* ("Bt" for short) that controls various caterpillars is avail-

able in liquid form. Sprayed onto your trees, the organism infects and kills the caterpillars when they eat the needles. Best of all, the disease is not harmful to other organisms, including humans.

You can also buy commercial virus preparations for sawflies (e.g., redheaded pine sawfly), or you can make your own. The "recipe" is included in the sawfly writeups. Once introduced, a virus persists and passes to sawflies year after year.

Keep predators and parasites working for you by minimizing chemical control. If you must use pesticides, apply the lowest recommended dose, and time and direct the treatment so as not to kill beneficial organisms. Also, try to spot-treat pests to further minimize pesticide use. You need not always treat an entire nursery or plantation if only a few trees or small clumps of trees have been affected.



Ladybugs feasting on aphid pests.



Lady bug adult.



Lacewing fly.



Parasitic wasp.



Lady bug larvae.



### **Cultural Control**

Ordinary cultural practices such as weed control, mowing, shearing, pruning, and thinning help make your nursery or plantation less appealing to pests. And if you strategically modify and time these operations, you can manipulate pest habitat to prevent and control problems even more effectively. For example, you can discourage mice by mowing the grass they hide in or reduce pine needle rust by removing nearby goldenrod and aster plants. Delaying shearing a few weeks can destroy European pine shoot moth, and pruning the lower branches off old trees helps control pine root collar weevil, European pine shoot moth, and some disease organisms.

The object is to make the habitat less favorable so pests will not multiply as rapidly. Sometimes even a slight drop in population can avert a damaging pest buildup and reduce the number of pesticide applications needed for control.

Cultural controls are among the simplest and cheapest methods available because they can be carried out in connection with usual management operations. And, like biological controls, cultural practices are environmentally safe.



*When timed correctly, routine shearing can slow down a pest buildup.*



*Discourage mice by mowing the grass they hide in.*

Photo by John F. Ahrens, Connecticut Agricultural Experiment Station.



### Legal Control

Forest and agricultural pests that overwinter, nest, or hide on nursery stock and Christmas trees are often carried into new locations as "hitchhikers." Once they enter new, uninfected areas, these pests commonly swell to epidemic levels. Lophodermium needlecast is a classic example of a serious fungal disease that rode on nursery stock to many Christmas tree plantations in previously uninfected States. New epidemics started when spores released from these newly planted seedlings spread to susceptible trees nearby. Sometimes, the only way to stop the spread of hitchhiking pests is through legal measures, such as quarantines or mandatory inspections. To avoid having Christmas trees intercepted by the State, always examine them before harvesting and shipping.

The gypsy moth and the cereal leaf beetle are two important hitchhiking pests to look out for. The gypsy moth is normally a hardwood pest, but when abundant, it can injure Christmas trees as well. Look for egg masses of the gypsy moth on the trunks of Christmas tree seedlings and trees. You may also find the cereal leaf beetle, a major agricultural pest, hiding under the bark scales of Christmas trees.

Many pests spend the winter on Christmas trees and may be inadvertently shipped to new areas at harvest time. Some pests, such as the European pine sawfly, can hatch out in buyers' homes at Christmas and become a nuisance. After the holidays, overwintering pests can be carried wherever old or unsold trees are discarded. Therefore, it is good practice to treat all trees just before harvest if they harbor overwintering pests. Failure to do so may lead to the spread of epidemics and the possible quarantine of valuable trees.

### Chemical Control

Chemical pesticides are among the most effective materials used to prevent, destroy, or repel pests, and because of this, they have been used too often in lieu of other control methods. If you must use pesticides, it is important to choose the proper chemicals and dosages and to avoid mistakes.

Improper use of a pesticide might rid your nursery or plantation of a pest, but may very well trigger another more serious problem. Overspraying, for example, usually causes mites, aphids, and scales to rapidly build up to damaging levels. Heavy dosages, poor timing, and careless application can kill valuable parasites and predators, allowing new pests to gain a foothold in your nursery or plantation. Because of these disadvantages, we stress using pesticides only as a last resort.

To maximize the benefits and avoid the hazards of pesticides, choose formulations that pose the least threat to nontarget species. Adjust and calibrate application equipment so the proper amount of pesticide hits the target, and only the target. (See "Calibration," p.93.) Time your treatment to avoid spray drift; windless days, early mornings, and evenings are good times to apply pesticides. We also suggest alternating pesticides if possible to reduce the chances of a pest developing resistance to a particular type of pesticide.

When used as directed and in combination with other controls, pesticides can produce impressive reductions in pest populations. To help you with the proper selection and uses of pesticides, this manual includes information about timing, equipment, and safety. We have purposely left out specific dosages, however, because they change so frequently. To find current dosage information, check the label on the pesticide container.



*A shipload of untreated trees may carry pests into new areas. Inspect before harvest to avoid quarantines.*



*Chemical control should be your last, rather than your first choice.*

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#### **Step 4. Evaluate Your Control Efforts**

To be truly effective, pest management should be part of the day-to-day workings of your Christmas tree operation, from species selection to premarket inspection. This includes regular, careful monitoring, even *after* a control treatment. By evaluating your treatments, you can decide which management techniques were successful, and which were not. You can then continue practicing the best techniques and reject or modify the others. In this way, you will be managing pests by design, not by chance.



*Prize-winning proof of good pest management.*



## Symptoms and Signs of Tree Injury

When you are protecting your investment from very small insects, hidden diseases, or pests that feed underground, it helps to have an eye for detail. If you know what to look for when inspecting your trees, you can spot a pest problem in its early stages and greatly reduce losses and control costs.

Most likely, you will see the results of pest activity long before you notice the pest. An injured tree will show symptoms such as unusual color, missing foliage, deformed parts, etc. Although these clues may help you diagnose (or identify) the injury, they may also mislead you. For example, an injury symptom of one pest may look exactly like the injury caused by several other pests. To complicate matters further, two or more pests may injure the tree at the same time, producing a new symptom by their interaction. Symptoms also change; yellow foliage may redden, turn brown, or fall off entirely. Therefore, you cannot rely on symptoms alone when you diagnose tree injury.

Reading the signs of the pest as well as symptoms of the host is usually the best way to tell one type of injury from another. Signs are the physical evidence of insect and disease activity and include the pests themselves (eggs, larvae, fruiting bodies), their enclosures (webs, cases, cocoons), debris (cast skins, wood slivers, pellets of waste), pitch flow, and associated insects or diseases such as ants and sooty mold. Sometimes, two different pests will produce look-alike symptoms and leave the same signs. In that case, the pest itself must be examined and identified by you or by a pest specialist. (See "How to Submit Material for Identification," p. 85.)

The detective work involved in identification becomes more difficult as time passes because both symptoms and signs change. A vigorous tree, by trying to heal itself, may mask or outgrow the injury. On the other hand, a weak tree will become susceptible to invading insects and diseases that can confuse the diagnosis by producing symptoms and

signs of their own. Signs such as webs, waste, or cast skins will also break down with time.

Therefore, the best time to "read" a symptom or sign is during the early stages of pest activity. To catch pests in action, start monitoring your trees at planting time and continue to examine them frequently throughout their lives. The following section describes the major symptoms and signs to watch for every time you inspect your nursery or plantation.

### Discolored Foliage

Discolored foliage can result from damage to any part of the tree—roots, trunk, branches, or needles. When a single needle or a small group of needles is discolored, damage is usually centered in the individual needles. For instance, needlecast fungi cause banding on the individual needles they infect. However, if an entire section of foliage on a shoot or branch is discolored (flagged), the injury is usually within or at the base of that section. Flagging may also be caused by drought, root injury, or a lack of nutrients—all problems occurring in the soil.



*This dramatic brownup is typical of stem or root injuries.*



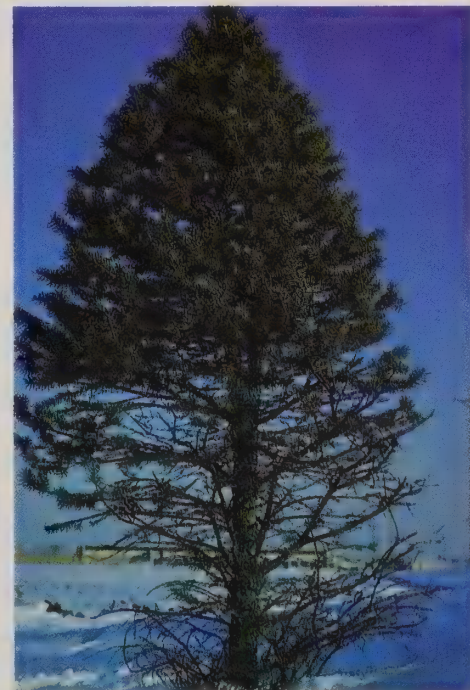
*Banding on needles is one symptom of a needlecast infection.*

Blackened foliage and/or bark indicates soft scales, aphids, or spittlebugs. A black sooty mold grows on the sugary "honeydew" and spittle produced by these insects. Needles and shoots covered by the eggs or bodies of insects may also look discolored. In these instances, you can directly identify the insects injuring your trees.

Herbicide damage, air pollution, and winter injury can also discolor foliage. When the whole tree is evenly discolored, the injury is usually on the mainstem, root collar, or roots.

### Missing Foliage

Needle loss is a common symptom of many insect and disease injuries. Foliage hit by winter injury or needlecast fungi will die and drop off early. Notched, broken, or hollowed-out needles indicate insect feeding. Insect foliage feeders will strip off clusters of needles, often in a characteristic pattern. Look for the insect or its waste, webs, cocoons, or cast skins on the surrounding foliage and beneath the injury; these are all signs of insect feeding. (See "Insect and Disease Parts and Structures" below.)



*Early needle loss thins and degrades infected Christmas trees.*



### Deformed and Stunted Tissues

Insects and diseases can cause galls, swellings, and other kinds of abnormal growth on needles, shoots, stems, or roots. Past injuries from insects, diseases, or animals may eventually cause excessive branching, forking, and crooking. Stunted shoots are caused by drought and frost damage, insects feeding on shoots and roots, or infection by shoot-blight fungi. Once weakened by injury or stress, trees often grow more slowly. Although economically important, this growth loss may be difficult to detect and diagnose. It begins gradually, sometimes a year or more after the agent that injured the trees has left.

### Pitch Flow

When insects feed or tunnel in the shoots and stems of living conifers, a pitchy substance commonly surrounds or flows from the point where they entered the tree. Canker and shoot blight infections may cause the same response.



Shoot crooking caused by European pine shoot moth.



Pitch mass on mainstem formed by Zimmerman pine moth larvae.

### Wood Shavings

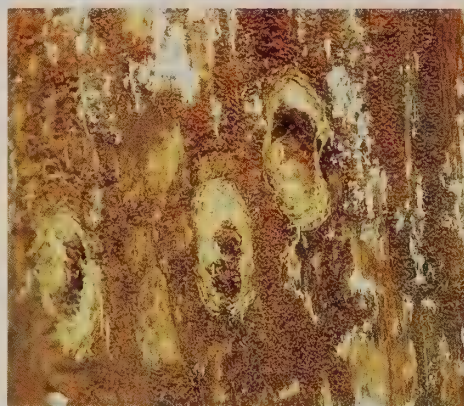
Insects living in dying or dead stems and branches often produce fine sawdust or coarse slivers of wood. Piles of this material on the ground or streaks of it adhering to the bark pinpoint the opening to the insect's tunnel.

### Insect and Disease Parts and Structures

Small pellets of waste left by foliage-feeding insects can be found near or beneath the damaged foliage. Spittlebug nymphs produce white, frothy masses resembling spittle on the twigs or branches of trees. Part the mass carefully to see the insect within.

As insects develop, they periodically shed their outer skin to accommodate changes in size. Skins of nymphs, larvae, or pupae, as well as old eggshells, can sometimes be found near the injury and used to identify the species of insect. Several species of foliage feeders will construct protective bags, webs, or cocoons that are also distinctive. Some wood-boring insects make pupal cells called chip cocoons in the wood where they feed.

Fungi produce spores in reproductive structures called fruiting bodies. These small structures are formed in the dead tissues of needles, shoots, and stems. Some species of fungi form characteristic sheets of fungal material called mycelial fans (see Armillaria root rot).



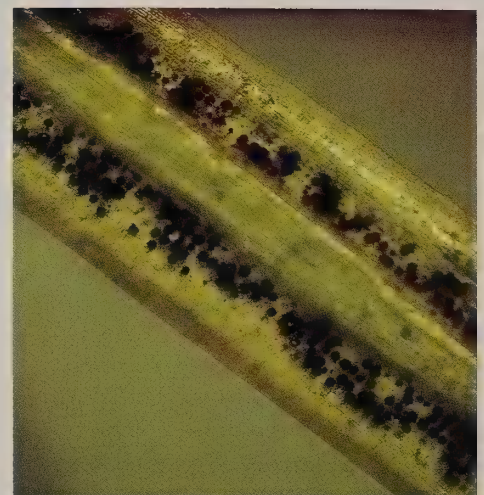
Shavings left by weevils.

Keep in mind that fungi found in dead tissues may or may not have killed the tree. Many fungi are secondary agents, which means they invade tissues *after* the host has been killed by something else.

In the next section, you will find descriptions and control recommendations for 70 species of pests, grouped by the type of injury they cause. Step-by-step instructions on how to track down a specific pest can be found on p. 6, "How to Use This Manual."



Spittlebugs earn their name by turning plant sap and saliva into a spittlelike mass of bubbles.



Dotlike fruiting bodies on needle infected with Swiss needlecast.



## How To Identify and Control Pests

- Needle Discoloration, p. 21
- Needle Feeding, p. 37
- Shoot/Branch Injury, p. 49
- Shoot/Branch Galls, p. 69
- Dead Tree and Stem/Root Injury, p. 75

## Needle Discoloration

Scattered, single needles or clumps of needles may be spotted, banded, stippled, or totally discolored—yellow, red, brown, or black. You may find fruiting bodies, swellings, or scales on injured needles. Some may be distorted. If needles are chewed off, see next section. If shoots, branches, or entire trees are discolored, see other injury categories.







## Air Pollution Injury

**Hosts:** All conifers, especially eastern white pine.

**Importance:** Air pollution reduces growth, causes early needle loss, increases vulnerability to diseases and insects, and occasionally kills trees.

**Look For:**

- *Yellowing, stunting, and early shedding of old needles.*
- *Yellow, red, or brown tips* on current-year needles.
- *Yellow flecks, stipples, or bands* on needles.
- *Injury on nearby broad-leaved plants*, e.g., dead tissue at leaf margins (fluorides) or between leaf veins (sulfur dioxide), or stippling (ozone). Aspen, birch, alfalfa, and sweetcorn are particularly sensitive to air pollution injury.

Factors that cause similar symptoms: Drought, p. 26; herbicide injury, p. 27.

**Biology:** Air pollutants produced by automobiles (ozone), industrial processes (fluorides), and coal and oil-burning factories (sulfur dioxide) will injure a wide range of plant species in or near Christmas tree plantations. The

amount of damage depends on the age of the needles, genetic make-up of the tree, pollutant concentration, weather, and how long the tree was exposed to the pollutant. New needles are most susceptible when elongating during early summer.

**Monitoring:** Not necessary.

**Control:**

THIS CROP

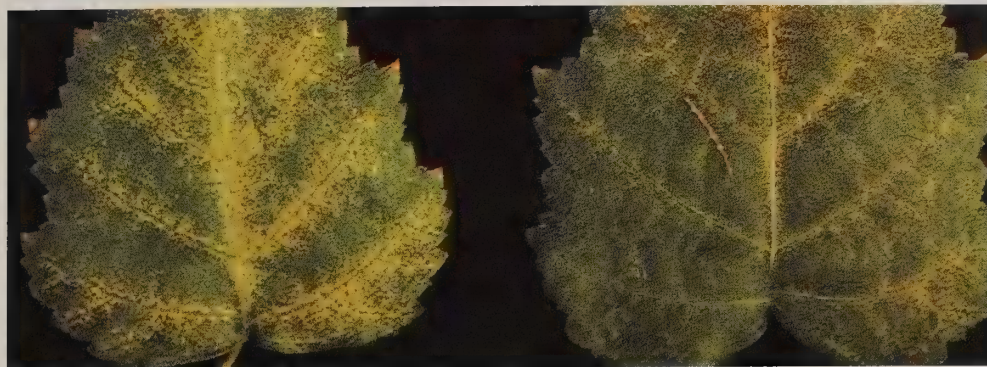
- Remove dead shoots and trees to prevent a buildup of pests on this material.

NEXT CROP

- Before choosing a new plantation site, check the surrounding area for industries that may produce damaging pollutants. Most damage occurs within 10 miles of these sources, however, ozone injury can also occur in remote areas.
- Plant seedlings that are genetically resistant to air pollution injury. For example, spruces are resistant to sulfur dioxide, ozone, and fluorides; balsam fir, Douglas-fir, and red pine are resistant to ozone.



*Yellow and brown tips on current-year needles.*



*Stippling on nearby leaves.*

## Balsam Gall Midge

**Hosts:** Balsam and Fraser fir.

**Importance:** The larvae of this midge cause small galls to form on needles. Galled needles drop prematurely, lowering the market value of affected Christmas trees. However, injured trees will recover satisfactorily if they are not infested again for 3 or 4 years.

**Look For:**

- *Thinned-out foliage* anywhere on the tree.

JUNE-OCTOBER

- *Galls--globelike swellings* near the bases of new needles. There may be several galls per needle in heavy infestations.
- *Small, yellow larvae* inside galls.

**Biology:** Parasites attack midge larvae that are in galls, and predators prey on the cocooned larvae in fall and spring. Adults are vulnerable to insecticides between late May and early June when they emerge to mate and lay eggs.

**Monitoring:** Look for galls anytime between June and October, starting 3 to 4 years before harvest. Consider treating individual trees if 5 to 10 percent of their needles are galled. There is no need to treat infestations lighter than this, because the midge's natural predators and parasites will keep low populations in check.

**Control:**

THIS CROP

- Kill adult midges by spraying heavily infested trees with a "systemic" or "contact" insecticide in late May or early June when needles are expanding. (See Pesticide Table.) To determine the best spray date, measure the length of three newly developing lateral (side) shoots (do not use terminal (top) shoots) on each of three trees, i.e., nine shoots. Measure every day and treat when the nine new shoots *average* 1½ in. long.
- Kill larval midges inside developing galls with an insecticide that has some systemic activity. If applied before mid-June, galls will stop forming and needle drop at harvest should be slight. Control is not practical after mid-June because larvae are then protected by fully formed galls.



## Brown Spot Needle Blight

### NEXT CROP

- Avoid planting balsam fir or Fraser fir where midges have been a problem. Replace with non-host conifers or, if available, plant varieties of fir that are more resistant to midge injury.



Galls caused by balsam gall midge.

**Host:** Scotch pine.

**Importance:** The browning and early needle loss caused by this fungus makes injured pines unsalable as Christmas trees.

### Look For:

- **Reddish-brown, resin-soaked spots with yellow margins**, on the needles. Spotted needles turn yellow, then brown.

- **Black fruiting bodies** flush with the surface of dead, dry needles. These fungal structures stick out from the needle when wet.

### AUGUST–OCTOBER

- **Brown needles**, especially on the lower branches and on the moist, shaded north side of trees. Needles turn brown from the tip towards the twig.

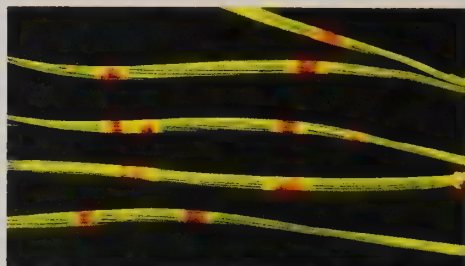
### MAY–JULY

- **New shoot and needle growth** on the tips of branches that hold dead, brown needles. Most dead needles fall off, leaving only tufts of new, green growth on the branch tips.

Pests that cause similar symptoms: Lophodermium needlecast, p. 28; pine needle scale, p. 31; winter injury, p. 36.

**Biology:** Prolonged wet periods, particularly during June and July, provide favorable conditions for heavy infection. Old needles are more resistant to infection than young ones.

**Monitoring:** Inspect trees of all ages at least once between August and October. Randomly select 50 or more trees scattered throughout the plantation. Look for needle spots and browning on current-year and older foliage on the lower branches. If 15 percent of these trees are injured, consider treating entire plantation next spring. If the infection occurs in small pockets, treat only the infected and surrounding trees.



Reddish-brown spots with yellow margins on needles.



Black fruiting bodies on dead needles.



Brown needles on lower branches.



New growth on the tips of branches that hold dead needles.



## Dothistroma Needlecast

### Control:

#### THIS CROP

- Cut and immediately remove small pockets of up to five infected trees. Treat trees within 30 ft. of infected area with a registered, preventive fungicide. (See Pesticide Table.)
- Or, if needed, apply a registered, preventive fungicide to all trees when needles are about half grown. Repeat two or three times, once every 2 to 3 weeks to protect new growth and old foliage.
- Do not leave live, infected branches on stumps of harvested trees; they serve as disease reservoirs.
- Do not shear infected foliage during wet weather because spores released at this time may be carried from tree to tree on workers' clothes or shearing tools. Sterilize tools after shearing infected plantations by dipping in denatured alcohol for 3 minutes.
- Shear healthy plantations first so disease spores will not be carried into them from infected plantations.

#### NEXT CROP

- Plant only pest-free stock. If you suspect infection, have seedlings examined by a pest specialist.
- Plant disease-resistant varieties of Scotch pine, such as the long-needled varieties from Central Europe. (See table on p. 11 for resistance rankings of Scotch pine.)
- Plant more than one species or variety so that one disease will not damage the entire crop.
- Do not plant Scotch pine seedlings next to Scotch pine windbreaks. Cut and chip or burn these windbreaks the year before a new stand is planted. Remove the stumps, or treat them with a registered insecticide to prevent pales and northern pine weevil attack. (See these weevils in Pesticide Table.)

**Host:** Austrian pine.

**Importance:** This fungus attacks and kills needles of all ages. Severe infection can kill trees or make them more susceptible to other diseases.

### Look For:

#### FALL

- **Yellow to tan needle spots** that enlarge to form distinct brown to reddish-brown bands.
- **Dead needle tips** beyond the reddish-brown bands. Needle base remains green.
- **Black fruiting bodies** in dead spots or bands on needles.

Pests causing similar symptoms: Pine needle scale, p. 25; winter injury, p. 36.

**Biology:** Spores spread by wind and rain can infect needles throughout the growing season. However, new needles are not susceptible until they have emerged from the needle sheaths. Fungal fruiting bodies appear in the fall, and spores are released the following spring and summer.

**Monitoring:** Check trees of all ages in the fall. If you find needle spots on any of your trees, consider treating the entire plantation next year. Take other preventive measures immediately to avoid spreading the disease.

### Control:

#### THIS CROP

- Do not shear foliage when wet because spores released at this time may be carried from tree to tree on shearing tools.
- Apply a registered fungicide once between mid-June and mid-July to protect all foliage. For complete control, consider spraying once before this, in mid- to late-May. (See Pesticide Table.)
- Do not ship infected Christmas trees because this fungus "hitchhikes" to new areas this way.

#### NEXT CROP

- Plant only pest-free nursery stock.
- Avoid planting Austrian pine. This exotic host is also very susceptible to winter injury.
- If you plant Austrian pine, plant disease-resistant varieties. Trees from a Yugoslavian seed source have shown resistance to Dothistroma.
- Do not plant near windbreaks infected with Dothistroma.
- Take preventive measures as described above to protect new foliage.

*Dead needle tips.  
Inset: Brown bands on needles.*





## Drought Injury

**Hosts:** All trees.

**Importance:** Drought-stressed trees lose foliage, grow slowly, and become more susceptible to attack by insects and diseases. This is especially true of younger trees. Severe drought may kill trees.

**Look For:**

- *Wilting, dying needle tips and discolored foliage* on the top branches. Symptoms may not appear until a year or more after trees have been stressed by drought.
- *Dead tree top*, shortened needles, and sparse foliage. These indicate a general decline in vigor that becomes evident in the years following the drought.

Pests that cause similar symptoms: Air pollution, p. 23; Armillaria root rot, p. 77; Cytospora canker, p. 53; Diplodia shoot blight and canker, p. 54; eriophyid mites, p. 26; herbicides, p. 27; Rhizosphaera needlecast, p. 33; scleroderma canker, p. 65.

**Biology:** Drought stress occurs when trees need more moisture than is available in the soil. This condition may be caused by one growing season of severe drought or several seasons of

below-normal rainfall. Young trees are especially sensitive to drought because their root systems are less extensive than those of older trees.

**Monitoring:** Inspect stressed trees of all ages for injury by invading pests during and after periods of drought. Follow control recommendations for each pest as needed.

**Control:**

THIS CROP

- Control weeds and grasses in and around plantation to reduce competition for water during dry periods. (See "Weeds, broad-leaved" and "Weeds, grass", in Pesticide Table.)
- If drought conditions persist, irrigate to replace soil moisture in the root zone.
- Remove all dead trees as soon as possible; they may harbor bark beetles.

NEXT CROP

- Do not plant shallow-rooted species in areas of low rainfall or on drought-prone sites.
- Remove weeds from site before planting.
- Irrigate during dry periods. This is especially important for young trees.



*Wilting, dying needle tips.*



*Dead tree top.*

## Eriophyid Mites

**Hosts:** Scotch, Austrian, red, and white pine.

**Importance:** Immature and adult eriophyid mites discolor and distort foliage on pines by feeding on the buds and needles. Heavy attacks degrade Christmas trees.

**Look For:**

- *Blotchy, pale yellow, stippled needles.* The tip of each shoot may have an exceptional number of buds, and needles may be twisted or hooked.

APRIL-OCTOBER

- *Cream-colored mites*, only 1/125 in. long, between the needles or inside needle sheaths. To verify, pull the needle cluster apart until the needle sheath splits; then closely examine the lower part of the needle with a hand lens.

Factors that cause similar symptoms: Drought, p. 26.

**Biology:** Several overlapping generations of eggs are laid on the needle sheaths, starting when the weather warms. Though minute, mites are often numerous enough to degrade and weaken a tree by feeding on the tree's sap under the needle sheaths. Mite populations can swell when their natural enemies are inadvertently killed by repeated use of insecticides for other Christmas tree pests.

**Monitoring:** Inspect trees of all ages throughout the growing season. Treat entire stand as soon as you notice needles discolored by mites.

**Control:**

THIS CROP

- Drench trees in infested areas with a registered miticide anytime between May and September to kill adults, and follow-up with a second drench 10 to 14 days later to kill newly hatched mites. The best time to treat for mites is mid-May to mid-June, before needles fully elongate. (See Pesticide Table.)
- Do not ship infested Christmas trees because overwintering mites "hitchhike" to new areas this way.

NEXT CROP

- Limit the use of insecticides to avoid killing off mite predators.



## Fall Needle Drop



Blotchy, pale yellow needles.



Eriophyid mites on Scotch pine needles.

**Hosts:** All Christmas tree species.

**Importance:** Fall yellowing of inner foliage is a natural occurrence and does not harm Christmas trees before or at time of harvest. It is especially noticeable on eastern white pine.

**Look For:**

SEPTEMBER-NOVEMBER

- *Yellowing and browning of the oldest foliage* anywhere on the tree.

Pests that cause similar symptoms: Naemacyclus needlecast, p. 29.

**Biology:** All conifers shed their oldest needles each year. These needles turn bright yellow or brown in September or October and drop off at or before the harvest period. A healthy tree should have at least 2 years of needles after the oldest needles drop off.

**Monitoring:** Not necessary.

**Control:** Not necessary.



Yellowing of old foliage.

## Herbicide Injury

**Hosts:** All conifers.

**Importance:** Herbicides that are improperly applied or that drift while being applied can kill needles and shoots on nontarget trees. Christmas trees suffer growth loss and in some cases, die because of accidental contact with herbicides.

**Look For:**

- *Yellow, bleached, or brown needles*, especially new needles on the side of tree exposed to the herbicide.
- *Twisted needles and hooked, distorted, or swollen shoots*.

Factors that cause similar symptoms: Air pollution, p. 23; drought, p. 26.

**Biology:** Herbicides can enter trees from above or below the soil line. Hormone-type herbicides cause abnormal, exaggerated growth. Others slow growth by inhibiting photosynthesis or other life processes. The type and degree of injury will depend on the chemical, the concentration reaching the tree, and the time of year.

**Monitoring:** Check for injury during the first few weeks after herbicide application.

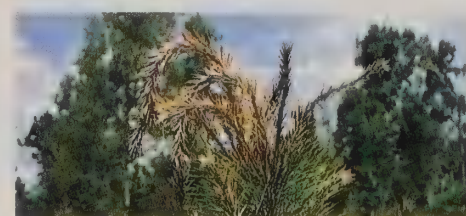
**Control:**

THIS CROP

- Prune off dead shoots.
- Remove dead trees so that insects and diseases cannot build up on them and spread to nearby, healthy trees.

NEXT CROP

- Use selective herbicides that are not toxic to conifers.
- To reduce drift, adjust spray equipment to proper pressure and droplet size, add "thickeners" to herbicide, and do not spray on windy days.
- Avoid planting Christmas trees near areas where herbicides are routinely used, e.g., powerlines, roadsides, and agricultural fields.



Hooked shoots caused by picloram.



## Lophodermium Needlecast

**Hosts:** Scotch and red pine.

**Importance:** This fungus kills red pine seedlings and causes dramatic browning on Scotch pines of all ages. Heavily infected trees, weakened by early needle loss, are disease prone and unfit for sale as Christmas trees.

### Look For:

MARCH-APRIL

- **Brown spots with yellow margins** on the needles. Eventually, needles turn yellow, then brown.

MAY-JUNE

- **Brown needles, especially at the bottom of the tree.** When severely infected, the whole tree will brown up.

JUNE-JULY

- **Fresh shoot and needle growth on the tips of branches that hold dead, brown needles.** Most dead needles fall off in June, July, and August, leaving only tufts of new, green growth on the branch tips.

JULY-OCTOBER

- **Black, football-shaped fruiting bodies** on dead needles. Lophodermium fruiting bodies have a lengthwise slit down the middle and stick out from the needle when wet.



Brown spots with yellow margins on the needles.



New shoot growth on damaged branches.



Lophodermium fruiting body.

Brown needles on infected Scotch pine.



## Naemacyclus Needlecast

Pests that cause similar symptoms: Brown spot needle blight, p. 24; pine needle scale, p. 31; winter injury, p. 36.

**Biology:** The wind spreads *Lophodermium* spores from diseased needles to healthy needles in moist weather from August through October. The fungus overwinters in pine needles. In the spring, it destroys the water-conducting system in needles, causing the foliage to turn brown.

**Monitoring:** Examine trees of all ages in May or June. Look for needle spots and brown foliage on the lower branches of 50 or more trees scattered throughout the plantation. If 10 percent of the trees are injured, consider treating the entire plantation starting in late July.

### Control:

#### THIS CROP

- Irrigate nursery seedlings in the morning so that they will have time to dry in the afternoon. This will avoid the prolonged periods of moisture that favor *Lophodermium* infection.
- Do not ship infected nursery stock or Christmas trees because *Lophodermium* "hitchhikes" to new areas this way.
- Do not leave live, infected branches on stumps of harvested Christmas trees; they serve as disease reservoirs.
- Apply a registered, preventive fungicide three or four times, once every 2 to 3 weeks during the major infection period from late July through October. Apply more frequently if wet weather persists. (See Pesticide Table.)

#### NEXT CROP

- Do not bring infected transplant stock into nursery.
- Plant only pest-free stock. If you suspect infection, have seedlings examined by a pest specialist.
- Do not plant seedlings next to windbreaks of the same species. Cut and burn same-species windbreaks the year before a new stand is planted. Remove the stumps, or treat them with a registered insecticide to prevent pales and northern pine weevil attack. (See these weevils in Pesticide Table.)
- Plant disease-resistant varieties, e.g., long-needled Scotch pines. (See table on p. 11 for resistance rankings of Scotch pines.)

**Host:** Scotch pine.

**Importance:** The early yellowing and needle loss caused by this fungus weakens and degrades Christmas trees.

### Look For:

#### SEPTEMBER

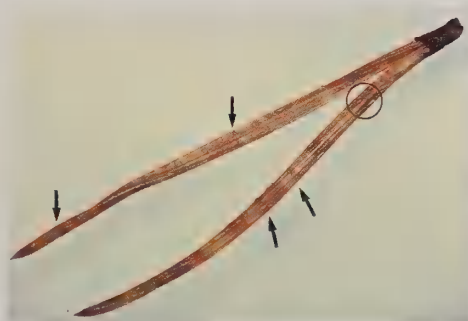
- **Light-green spots on 2- and 3-year-old needles.** Spots enlarge and lighten in color, and needles eventually turn yellow, then brown.
- **Yellow needles with dark-brown, horizontal bands.**

#### OCTOBER-MAY

- **Shedding of yellow needles** anywhere on the tree.
- **Off-white, waxy fruiting bodies** on brown needles. Most noticeable in wet weather due to swelling.

Pests that cause similar symptoms: Fall needle drop, p. 27; pine needle scale, p. 31; winter injury, p. 36.

**Biology:** Scotch pine needles of all ages are susceptible to infection. Most trees are infected between mid-April and late June, but infection is possible through December. *Naemacyclus* spores spread most readily after rainfall.



Yellow needles with dark bands (arrows) and fruiting body (circle).



Yellow needles anywhere on tree.

**Monitoring:** Inspect trees of all ages in late fall and early spring. Examine 50 or more trees randomly scattered throughout the plantation. If 20 percent of them show symptoms of *Naemacyclus* on the 2-year-old needles, consider treating entire plantation in early spring.

### Control:

#### THIS CROP

- Apply a registered, preventive fungicide three times, once every 2 to 3 weeks between mid-April and late June, starting *before* Scotch pine buds open. This control is about 50 percent effective. Continue spray schedule into late fall for complete control. This treatment may be too expensive for some growers. (See Pesticide Table.)

#### NEXT CROP

- Buy planting stock from a nursery that uses preventive treatments for all diseases.
- If available, plant stock from seeds of trees that show genetic resistance to *Naemacyclus*. The Northern European seed sources appear to be more resistant than the Mediterranean sources.
- Avoid planting next to old Scotch pine windbreaks.



Yellow needles with dark-brown bands.



Off-white, waxy fruiting bodies on needles.



## Pine Needle Rust

**Hosts:** Red and Scotch pine.

**Alternate Hosts:** Goldenrod, aster.

**Importance:** Most common on young trees up to sapling size, needle rust slows growth and causes unsightly foliage. When combined with insects and other agents that attack current-year foliage, needle rust may seriously damage or kill seedlings.

**Look For:** (On pine)

APRIL-MAY

- *Frosty-orange droplets on needles at the onset of warm weather.*

MAY-JUNE

- *Orange blisters erupting from needles on lower branches.*

**Look For:** (On goldenrod or aster)

JULY-AUGUST

- *Orange spores on the undersides of leaves.*

AUGUST-SEPTEMBER

- *Orange, cushiony bumps on the undersides of leaves.*

**Biology:** This fungus needs both pine and a herbaceous host to complete its 1-year life cycle. Pine needle rust spores produced on pine do not infect pine. Windborne spores from pine needles infect goldenrod or aster, and only spores produced on these alternate hosts can infect pines. Needle rust overwinters in pine needles. The fungus is perennial, so it can survive 2 consecutive years of unfavorable weather.

**Monitoring:** Examine 3- to 6-year-old trees in May and June. Check the needles of at least 50 trees scattered throughout the plantation. If you find orange blisters and serious foliage loss on more than 25 percent of these trees, remove goldenrod and aster in and around the plantation before August.

**Control:**

THIS CROP

- Mow goldenrods and asters before August to avoid using a herbicide. These plants are perennial and will need mowing each year until the trees are old enough for the rust to have little or no impact on tree quality.

- Or, kill goldenrods or asters concentrated within 1,000 ft of newly planted seedlings before August by applying a registered herbicide. Without its alternate host, the fungus will not be able to complete its life cycle or infect pines. (See "Weeds, broad-leaved" in Pesticide Table.)

NEXT CROP

- If practical, remove tall grass, weeds, goldenrod, and aster in and around plantation before planting. Avoid planting on humid sites north or west of a stand of tall trees, and avoid steep, northern or western slopes. If you must plant on these sites, plant conifers that are resistant to pine needle rust.
- Plant pines next to 16- to 20-ft-tall windbreaks of resistant shrubs and trees that will separate pines from their alternate hosts. Because windbreaks intercept spores and alter air currents, fewer spores reach the pine needles.



Orange blisters erupting from needles.



Orange, cushiony bumps on the undersides of leaves.



## Pine Needle Scale

**Hosts:** All pines and spruces; Douglas-fir; eastern redcedar.

**Importance:** This insect weakens trees by sucking sap from the needles and killing shoots. Heavily infested trees have sparse, discolored foliage and low vigor and cannot be sold as Christmas trees.

### Look For:

- *White-flecked or brownish foliage.*
- *Many white or light-yellow, oyster-shaped scales*, about 1/10 in. long, covering the needles. Large scale populations can cause trees to look greyish green. The scales can be scraped off with a fingernail.

Pests that cause similar symptoms: Most needlecast diseases (See "Needle Discoloration" section); sawflies (eggs look like scales) pp. 39, 42, 45.

**Biology:** Small, reddish eggs overwinter on the needles beneath dead, female scales. The crawlers (nymphs) hatch in mid-May, move to new hosts, and settle on the needles to feed and grow. The scales mature in early July

and produce a second generation of crawlers by mid-July. While growing, the scales secrete and cover themselves with a waxy coating that most pesticides cannot penetrate.

**Monitoring:** Inspect trees of all ages, looking for white flecks on the needles before lilacs bloom in spring. Delay control of light infestations on young trees, especially if predators such as ladybugs or lacewings are abundant on trees. These predators may curb an infestation. Treat individual trees when you see 5 to 10 white flecks per shoot. Treat entire plantation if scale infestation increases, or if trees are within 2 years of harvest. Treat all infested trees before shipping.

### Control

#### THIS CROP

- Cut and remove severely infested trees.

- Spray trees thoroughly with a registered insecticide in mid-to-late May, when lilacs are in full bloom, to control first-generation crawlers. Spray again if needed in late July or early August to control the second generation. (See Pesticide Table.)

- Or, apply dormant oil in late fall or early spring when trees are dormant. This treatment will do little harm to scale predators. (See Pesticide Table.)

- Do not ship infested Christmas trees because overwintering eggs "hitchhike" to new areas this way.

#### NEXT CROP

- Reduce spraying for other pests in new plantings whenever practical. Scales often reproduce rapidly after repeated spraying for other insects, because the insecticides kill the scales' natural enemies along with the target pests.



Clusters of pine needle scales give needles a pale, "snowy" look.



## Pine Thrips

**Hosts:** Scotch and Austrian pines.

**Importance:** When severe, pine thrips feeding can distort needles and weaken, stunt, or kill Christmas trees or seedlings. Heavily injured nursery seedlings are unfit for outplanting and injured trees are unsuitable for Christmas tree sale.

**Look For:**

- *Discolored, crooked needles, particularly on the upper branches.* Severely injured trees die and lose their needles.
- *Curled needles* anywhere on the trees. Needles growing from the same sheath may differ in size.
- *Brownish wounds*, 1/8 to 1/4 in. wide, on the needles.

LATE APRIL–OCTOBER

- *Orange-yellow or black insects*, up to 1/16 in. long, on the buds or new needles. Use a hand lens to see them clearly.

**Biology:** The winged, black, adult thrips lay their eggs in May. Several subsequent generations produce thousands of insects that feed on trees throughout the summer. Hot, dry weather favors their buildup.

**Monitoring:** Inspect trees of all ages throughout the growing season. Examine 30 or more trees in late

summer. If an average of 10 percent of the needles in the tops of the trees show damage, treat entire nursery or plantation next spring. Treated trees will usually outgrow the injury in 2 to 3 years.

**Control:**

THIS CROP

- Irrigate nursery seedlings frequently during hot, dry weather. Water with overhead sprinkler system early in the morning to discourage thrips and to reduce the likelihood of needlecast disease.
- Do not ship infested nursery stock or infested Christmas trees because overwintering thrips "hitchhike" to new areas this way.
- Thoroughly drench trees with a registered insecticide once in late April or early May before eggs are laid to control adult thrips. If you delay treatment until later in the season, two or three applications may be needed for complete control. (See Pesticide Table.)

NEXT CROP

- Do not bring infested transplant stock into the nursery.
- Do not outplant infested nursery stock.

## Rhabdocline Needlecast

**Host:** Douglas-fir, especially Rocky Mountain variety.

**Importance:** The browning and early needle loss caused by this fungus make Douglas-firs unsalable as Christmas trees.

**Look For:**

LATE FALL

- *Yellow spots on infected needles.* Spots eventually enlarge and cause mottling.

EARLY SPRING

- *Yellowish-brown to reddish-brown needles.*

EARLY SUMMER

- *Shedding of brown needles.* Heavily infected trees will keep only their current needles.

Pests that cause similar symptoms: Pine needle scale, p. 31; Swiss needlecast, p. 35.

**Biology:** Fruiting bodies that develop on the brown needles release spores during moist weather from May to July. Windborne spores infect only the young needles of opening buds on trees nearby or in other plantations.



Brownish wound and a black, adult thrips.



Reddish-brown needles.

Photo by Daniel G. Mosher, Michigan Department of Natural Resources.



## Rhizosphaera Needlecast

**Monitoring:** Inspect 5- to 10-year-old trees in May. Examine the 2-year-old needles on 50 or more trees scattered throughout the plantation. If you find fruiting bodies on 20 percent or more of these trees, consider treating entire plantation in early spring.

### Control:

#### THIS CROP

- Shear healthy plantations first so fungal spores will not be carried on shearing tools from infected plantations to healthy ones.
- If possible, remove severely infected trees early in the rotation to prevent disease buildup.
- Apply registered fungicides when buds burst; repeat every 7 to 10 days until the buds are fully open. Fungicides applied after buds are fully open will not be effective. The fungicide treatment used for Rhabdocline will also control Swiss needlecast, another fungus that infects Douglas-fir. (See Pesticide Table.)

#### NEXT CROP

- Plant only pest-free nursery stock.
- Plant disease-resistant varieties of Douglas-fir. Plant the Rocky Mountain variety only from seed sources that show resistance to Rhabdocline.



*Shedding of needles in early summer leaves trees unsalable.*

**Host:** Colorado blue spruce; occasionally white spruce.

**Importance:** This fungus causes needles to turn purplish-brown and fall prematurely, thereby reducing the vigor and market value of Christmas trees. Three or four years of early needle loss kills branches and, in severe cases, the entire tree.

### Look For:

#### LATE FALL OR EARLY SPRING

- **Fuzzy, black fruiting bodies** sticking out of tiny, pore-like openings (stomata) on both green and yellow needles. Use a hand lens. The yellow needles later turn purplish brown.

#### JULY-AUGUST

- **Purplish-brown, 1- and 2-year-old needles**, most commonly on the lower branches. Most of these needles drop off by late fall.

Pests that cause similar symptoms: Drought, p. 26; pine needle scale, p. 31; spruce spider mite, p. 34.

**Biology:** Some infected needles remain on the tree throughout winter. The next spring, Rhizosphaera spores from this infected foliage are rain-splashed or manually spread to newly emerging needles. Although infection is possible from mid-April to October, it usually occurs during wet weather right after blue spruce buds break.

**Monitoring:** Inspect trees of all ages during May, especially 5 to 10 year olds. Randomly select 20 or more trees scattered throughout the plantation and remove three lower branches from each. Examine the white rows of stomata on the 2-year-old needles with a hand lens. If half the branches have fruiting bodies on 10 to 50 percent of their needles, consider treating the entire plantation in spring and summer.

### Control:

#### THIS CROP

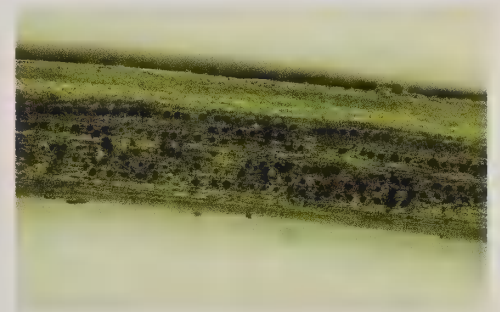
- Do not leave live, infected branches on stumps of harvested trees; they serve as disease reservoirs.
- Do not shear infected foliage during wet weather because spores released at this time may be carried from tree to tree on shearing tools. Sterilize tools after shearing infected plantations by dipping in denatured alcohol for 3 minutes.

- Shear healthy plantations first so disease spores will not be carried into them from infected plantations.

- Apply a registered, preventive fungicide when new needles are half elongated and again when needles are fully elongated. Two years of treatment should permit most trees to develop full foliage; heavily infected trees may take longer. If treated early, Rhizosphaera can be controlled in 1 year. (See Pesticide Table.)

#### NEXT CROP

- Plant only pest-free stock. Look for Rhizosphaera fruiting bodies on the needles and return all infected stock to the nursery.



*Fuzzy, black fruiting bodies in pore-like openings on needle.*



*Purplish-brown, 1- and 2-year-old needles.*



## Spruce Needle Rusts

**Hosts:** Black, white, and Colorado blue spruce; occasionally Norway spruce.

**Alternate Hosts:** Labrador tea; leather leaf.

**Importance:** During spruce needle rust epidemics, infected trees will lose 25 to 75 percent of their new needles, leaving them unfit for Christmas tree sale. Repeated attacks will slow growth but will rarely kill trees.

### Look For:

JULY-AUGUST

- *Yellow needles* anywhere on tree.
- *Whitish blisters filled with yellow spores on the undersides of current-year needles.*

AUGUST-SEPTEMBER

- *Shedding of infected needles.*

**Biology:** The fungi that cause spruce needle rusts need an alternate host to complete their life cycles. During the summer, windborne spores released from fungal blisters on spruce infect swamp heath plants such as Labrador tea or leather leaf. The fungi overwinter on these alternate hosts and spores released from them reinfect spruce the following spring.

### Control:

NEXT CROP

- Avoid planting spruce near swamps that contain Labrador tea and leather leaf.
- Plant resistant species of spruce such as Norway or black hills. White spruce is moderately resistant, but black and Colorado blue spruce are extremely susceptible.



*Whitish blisters filled with yellow spores on current-year needles.*



*Infected needles fall off in late summer.*

## Spruce Spider Mite

**Hosts:** All Christmas tree species.

**Importance:** Mites may discolor, degrade, or kill nursery stock and Christmas trees of all ages. Injury is most common during prolonged dry periods, on droughty soils, and where overuse of pesticides has destroyed the mites' natural enemies.

### Look For:

- *Yellowish to rusty-brown shoots.* Look close to see yellow mottling on needles.
- *Fine webbing between the needles.*
- *Dark-green to brown mites*, less than 1/50 in. long, on needles or webbing. To see mites, shake an injured branch over a piece of white paper, and focus a hand lens on the tiny, moving specks.

Pests that cause similar symptoms: Rhizosphaera needlecast, p. 33.

**Biology:** Mite eggs overwinter on the shoots. Nymphs hatching in May or June feed on the tree sap and spin webs. Adults appear in June or early July; three or more generations follow at 2½- to 3-week intervals until the weather turns cold. Mites are windblown to new areas or carried on infested nursery stock.

**Monitoring:** Examine trees of all ages throughout the growing season, beginning in June. Delay control if injury or webbing is barely noticeable or if rain-fall/humidity is high. However, if injury occurs during dry weather or if trees are to be harvested that year, treat individual, infested trees as soon as you notice symptoms.

### Control:

THIS CROP

- Drench infested trees with a registered miticide in mid-June or early July, and repeat every 2 weeks to kill mites emerging from eggs. Check for mites 1 month later and if needed, repeat double treatment again. (See Pesticide Table.)
- Or, spray trees thoroughly with a dormant oil early next spring before growth starts. (See Pesticide Table.)
- Do not ship infested nursery stock or Christmas trees because overwintering mites "hitchhike" to new areas this way.



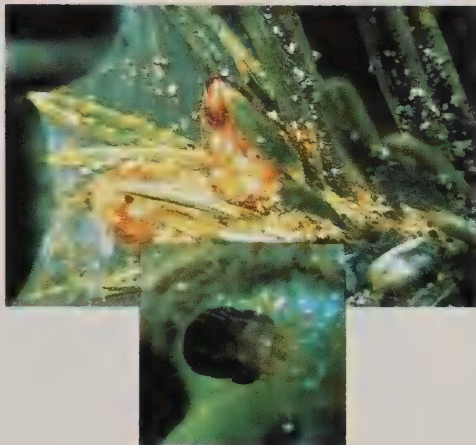
## Swiss Needlecast

### NEXT CROP

- Plant only pest-free nursery stock.
- Avoid planting on droughty soils, especially when planting spruce.



*Mottled needles.*



*Fine webbing between needles.  
Inset: Spruce spider mite on needle.*

**Host:** Douglas-fir.

**Importance:** The browning and early needle loss caused by this fungus results in thin-foliaged trees that are unfit for Christmas tree sale.

### Look For:

#### SPRING AND FALL

- **Rows of fuzzy, black fruiting bodies** in tiny, pore-like openings (stomata) on the undersides of both green and yellow needles. Use a hand lens to see them. Yellow needles later turn brown.

#### JULY-AUGUST

- **Brown, 2- and 3-year-old needles, especially on the lower branches.** These needles fall off in late August.

Pests that cause similar symptoms: Pine needle scale, p. 31; Rhabdocline needlecast, p. 32.

**Biology:** Airborne spores infect needles on new shoots during wet weather at the time of Douglas-fir bud break. Swiss needlecast is commonly spread by shipping infected nursery stock.

**Monitoring:** Inspect 4- to 10-year-old trees during May. Randomly select 20 or more trees scattered throughout the plantation, and remove three sample branches from each. Examine the white rows of stomata on the 2-year-old needles with a hand lens. If half of the branches have fruiting bodies on 10 to 50 percent of these needles, consider treating the entire plantation before summer.

### Control:

#### THIS CROP

- Do not shear infected foliage during wet weather because spores released at this time may be carried from tree to tree on shearing tools. Sterilize tools after shearing infected plantations by dipping in denatured alcohol for 3 minutes.
- Shear healthy plantations first so disease spores will not be carried into them from infected plantations.
- Apply a registered, preventive fungicide in the spring, when the new shoots are ½ to 2 in. long. Apply again in 2 to 3 weeks, and once again if rainfall is abnormally high. Two years of treatment should restore most trees to full foliage; heavily infected trees may take longer.

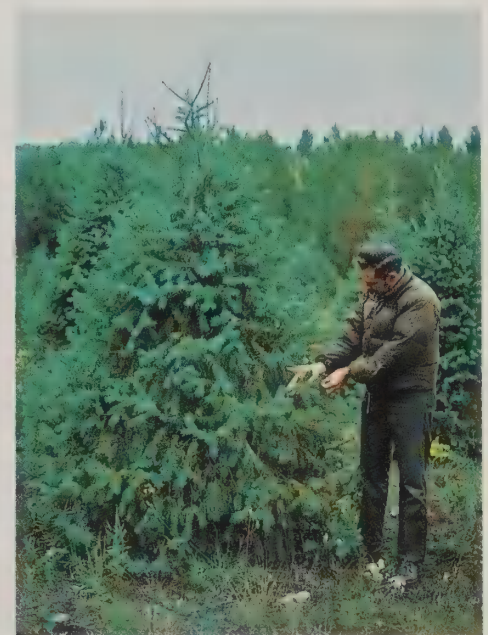
Treat nursery stock every 2 weeks from Douglas-fir bud break to mid-August. (See Pesticide Table.)

### NEXT CROP

- Plant only pest-free stock. Inspect planting stock carefully and return all infected stock to nursery.



*Rows of fuzzy, black fruiting bodies.*



*Brown, 2- and 3-year-old needles on lower branches.*



## Winter Injury

**Hosts:** Short-needled Scotch pine varieties; Austrian and white pine; Norway spruce; white fir; occasionally other Christmas tree species.

**Importance:** Winter burn and winter drying cause needles to turn brown and fall off, thereby degrading or making Christmas trees unsalable. Severe injury for several years may kill branches and occasionally kill trees.

### Look For:

- *Lack of foliage, especially on the south side of trees* where injury is usually most severe.

### APRIL-JUNE

- *Browning of entire tree or brown needles above the winter snowline* at the onset of warm weather. These needles drop and new buds usually develop normally.

Pests that cause similar symptoms: Brown spot needle blight on Scotch pine, p. 24; Dothistroma needlecast on Austrian pine, p. 25; Lophodermium and Naemacyclus needlecast on Scotch pine, p. 28, 29.

**Biology:** Water cannot move easily in soil and in trees in the winter, so when moisture is lost, it cannot always be replaced in sufficient amounts. When the soil around tree roots is frozen, warm winds can dry out and damage needle, bark, and bud tissues. Winter burn causes needles to turn brown during fast temperature changes, particularly on the south side of trees where exposure to the sun is greatest. Temperatures change quickly at sunset and sunrise or when sunlight is suddenly blocked by other trees, hills, or buildings. Sometimes, winter burn and winter drying will occur together, occasionally complicated by drought. The amount of injury depends on climate and on how well the Christmas tree species or variety can withstand winter conditions. Exotic trees (those grown outside their native ranges) tend to be especially susceptible to winter injury.

**Monitoring:** Select 50 or more trees of any age scattered throughout the plantation and look for browning between April and June. Keep accurate records of winter injury throughout the life of the trees. If more than 10 percent of them are periodically degraded by winter injury, avoid replanting the same species or variety on that site.

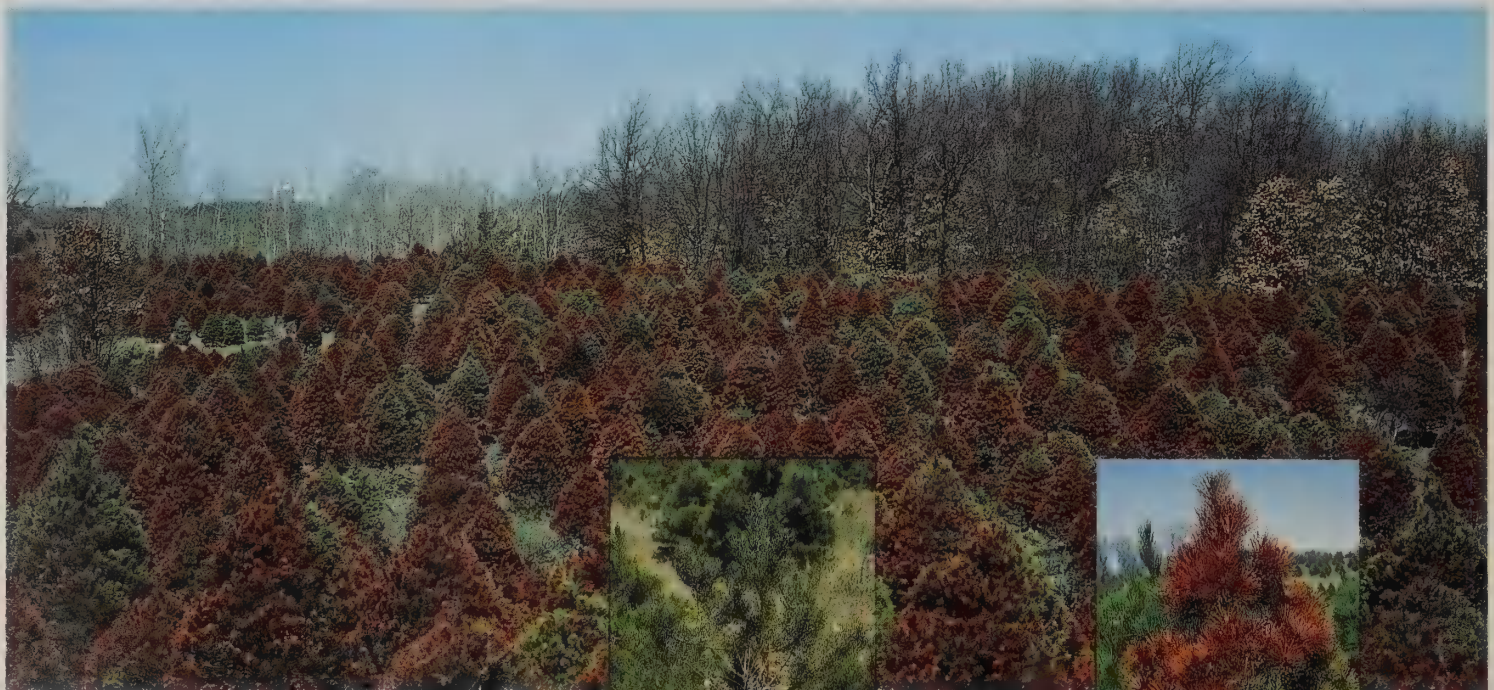
### Control:

#### THIS CROP

- Harvest old, susceptible trees as soon as possible after an injury-free winter.
- Figure the cost-benefit of keeping young, susceptible trees. If not profitable, destroy the trees and replant with resistant ones.

#### NEXT CROP

- Plant resistant species and varieties such as the long-needled Scotch pine varieties: red pine; white, blue, and Black Hills spruce; and balsam fir. (See table on p. 11 for resistance rankings Scotch pine.)
- Avoid planting susceptible species in open, wind-swept areas.
- Avoid planting susceptible species and varieties such as Spanish Scotch pine, Austrian pine, or Norway spruce. If you do plant susceptible trees, plant them in areas that are protected from the wind or in southern areas where temperatures are not as extreme.



Winter injury causes trees to lose needles, brown up above the snowline, or turn completely brown.



## Needle Feeding



Portions of needles or entire needles chewed off. Several needles may be clipped and webbed together into tubes, bags, or nests. Search for pellets of waste on the ground beneath injury to verify feeding and not simply needle drop.









## Bagworm

**Hosts:** Eastern redcedar; spruce; fir; eastern white pine.

**Importance:** Bagworm larvae attacks result in thin-foliaged trees marred by unsightly, brown, larval casings. Injured trees are unfit for Christmas tree sale and may be killed if larvae strip off all the foliage. This insect is most common in the southern portions of the North Central Region.

**Look For:**

- *Sparse or stripped foliage, especially at the top of the tree.* Shoot tips may be flagged (discolored and deformed).
- *Conspicuous, brown, silk bags,* 1 ¾ to 2 in. long, disguised with needle particles from the host tree.

**Biology:** The wingless female moths lay eggs in the fall inside silken bags. Larvae emerge, feed, and spin silken bags during June and July. In late August, they secure the bags to twigs. Because larvae move only short distances and females never leave the securely attached bag, damage may be confined to a single tree.

**Monitoring:** Begin monitoring trees of all ages in May and continue throughout the growing season. Treat by hand until infestation becomes especially heavy or widespread.

**Control:**

**THIS CROP**

- Hand pick and destroy old silken bags, which will contain eggs, moths, or larvae, depending on the time of the year.
- Cut out and destroy individual trees that are heavily infested.
- For widespread infestations, drench trees with Bt (*Bacillus thuringiensis*) solution from late May to early July to control the young, feeding larvae. (See Pesticide Table.)
- As a last resort, spray trees with a registered insecticide once between early June and mid-July to control feeding larvae. (See Pesticide Table.)
- Do not ship infested Christmas trees because overwintering bagworms "hitchhike" to new areas this way.

**NEXT CROP**

- Before planting, remove infested hosts in natural stands or windbreaks near the site.
- Plant less eastern redcedar, or replace with non-host conifers.
- Increase spacing between trees when planting to reduce the spread of bagworm.

## European Pine Sawfly

**Hosts:** Scotch, Austrian, red, and Virginia pine.

**Importance:** The larvae of this sawfly strip the old needles from pine Christmas trees, giving them a thin look in autumn. The trees outgrow the injury and recover their full, dense look in 2 or 3 years.

**Look For:**

- *Sparse or missing old foliage* anywhere on the tree.

**APRIL-MAY**

- *Tufts of dry, strawlike needle remains* behind new, green growth.

**APRIL-JUNE**

- *Green-striped larvae,* up to 1 in. long, with shiny black heads, in clusters on the old foliage. There may be as many as 100 larvae in a cluster.

**SEPTEMBER-APRIL**

- *Rows of yellow eggs* in slits in the needles.

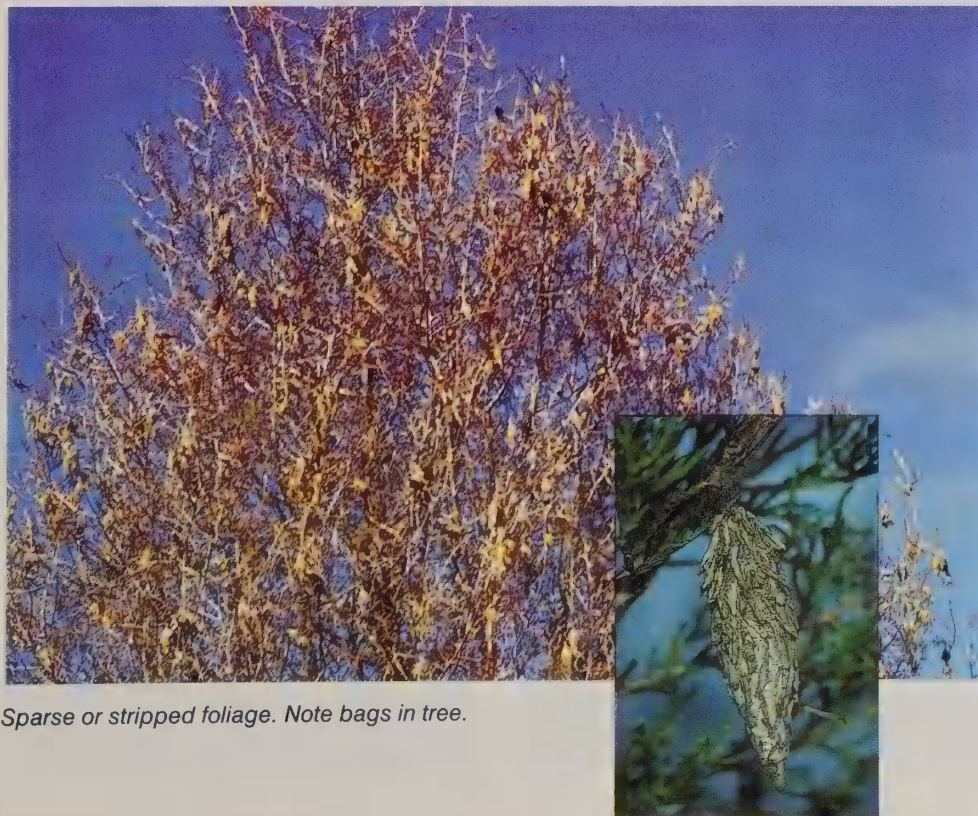
**Biology:** Adult females lay their eggs in clusters in the needles in September and October. The eggs overwinter and hatching begins in mid-April to early May. Young larvae feed in groups on the outer edges of old needles and produce tufts of dead needle remains. Older larvae eat entire needles and leave only the needle sheaths. One larval colony of 80 to 100 larvae can eat all the old foliage off a 2-ft-tall tree; 15 to 20 colonies can completely defoliate a 6-ft-tall tree. When full grown, larvae drop to the ground, spin cocoons, and pupate.

**Monitoring:** Begin inspecting trees 3 years before harvest, or when many small trees are repeatedly defoliated. Look for eggs from September to April, and look for larvae or damage from April to June. Treat infested trees as soon as you see larvae.

**Control:**

**THIS CROP**

- If colonies are few and scattered, knock the larvae off and crush them.
- Infect larvae with a virus that is known to kill that species. If a specific virus is not available, you can make a virus suspension from the diseased larvae in your nursery or plantation. Look on partially defoliated windbreak or plantation trees for freshly-killed, diseased



*Sparse or stripped foliage. Note bags in tree.*



larvae that are soft and black and hanging head-down from the foliage. At this stage, the larvae are like sacks full of virus particles. Place 100 to 150 dead larvae in a pint of chlorine-free water (distilled or rainwater), and allow them to disintegrate until the following winter or early spring. Then, filter the solution through a fine, cotton cloth or stocking to remove the debris. The pint of stock solution is then ready to use. For knapsack or hydraulic sprayers, prepare a spray solution with 2 or 3 tsp of stock solution per 6 gal of water. Add 5 level tsp of powdered milk or some other "sticker" to each gallon to help the spray solution adhere to the trees. Drench larvae and surrounding foliage shortly after the larvae emerge from the eggs. The virus will usually kill larvae in 4 to 10 days and continue to control sawflies until the trees are harvested.

- If a virus suspension is not available, apply a registered insecticide directly to larvae. (See Pesticide Table.)
- Do not ship nursery stock or Christmas trees that have sawfly eggs in the needles. Larvae may hatch in buyers' homes and feed on the trees at Christmas.

#### NEXT CROP

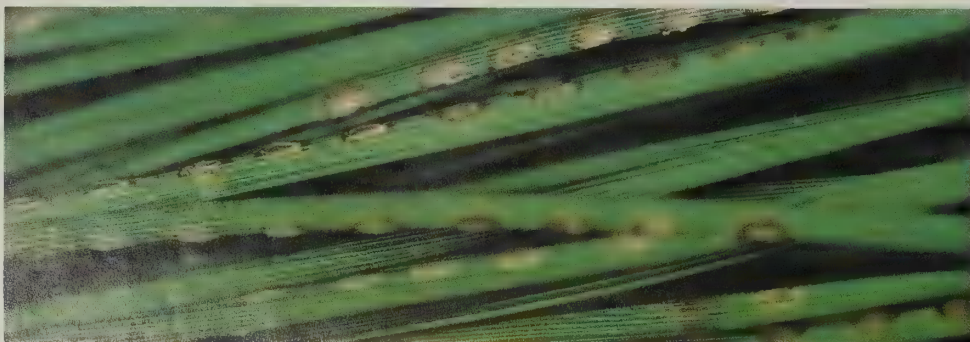
- Plant more resistant varieties of Scotch pine such as Swedish (Riga), N. Italian, or others. (See table on p. 11 for resistance rankings of Scotch pine.)



Dry, strawlike needle remains.



European pine sawfly larvae.



Rows of European pine sawfly eggs.

## Grasshoppers

**Hosts:** All Christmas tree species.

**Importance:** When grasses and field crops are in short supply, grasshoppers of many species will eat Christmas tree foliage. Grasshoppers in large numbers commonly kill seedlings planted in grassy areas, or devour the needles and bark of larger trees, making them unsalable for several years.

#### Look For:

- *Ragged needles* that have been partly or completely chewed off.
- *Scarred bark on twigs and branches, covered with hardened globs of pitch.* Seedlings may be almost completely eaten.

#### MID-JULY–OCTOBER

- *Large numbers of grasshoppers*, up to 1¼ in. long, feeding or resting on needles.

**Biology:** Grasshoppers become Christmas tree pests when their own food supply—grasses and field crops—is scarce. Therefore, damage is most likely to occur during a drought or after fields near Christmas trees have been plowed, mowed, or harvested.

**Monitoring:** In areas where grasshopper injury is likely, examine trees of all ages regularly from mid-July through October. Treat if 5 percent of Christmas tree foliage is injured. If noticed early enough, only the several rows nearest the edge of the plantation may need treatment.

#### Control:

##### THIS CROP

- Apply a registered insecticide directly to trees and grasshoppers, usually in August or September. (See Pesticide Table.)

##### NEXT CROP

- Remove grassy vegetation on or near the site before planting.



Ragged needles and grasshopper.



## Gypsy Moth

**Hosts:** Pines, spruces; occasionally fir and eastern redcedar.

**Importance:** Gypsy moth larvae feed heavily on hardwood trees, and when abundant and hungry they will feed on almost any Christmas tree species near their usual hosts. Feeding degrades the trees and may kill them. Lightly injured trees eventually outgrow the damage, but heavily injured ones remain unfit for sale.

### Look For:

- *Patches of missing foliage* anywhere on the tree. Entire tree may be defoliated.
- *Tan egg masses* on the stem and larger branches.

### MAY-JUNE

- *Hairy caterpillars*, up to 2½ in. long, with black, blue, red, and yellow markings. The head is mottled yellow and black.

### MID-JULY–EARLY AUGUST

- *Whitish moths* on the larger branches and mainstem.

**Biology:** The larvae hatch from egg masses on hardwood trees in April or early May and then drop down on silken threads and move on wind currents. They feed on hardwoods for 6 or 7 weeks until fully grown. Once they exhaust their normal food supply, they may move to Christmas trees. Adults begin to emerge in mid-July. The females, which do not fly, lay their eggs on the trunk and branches of the same host on which they fed.

**Monitoring:** Inspect trees of all ages from April to early August and treat as soon as you notice larvae.

### Control:

#### THIS CROP

- Spray trees with a registered insecticide to control larvae (April to June) or adult female moths (July to August). (See Pesticide Table.)
- Destroy egg masses by crushing them or soaking each with a dab of creosote or petroleum oil.
- Do not ship infested trees because overwintering eggs "hitchhike" to new areas this way.

#### NEXT CROP

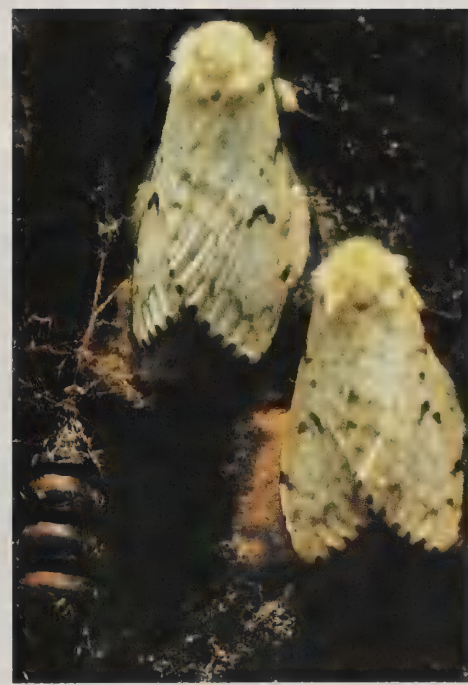
- Plant new stands away from susceptible or infested hardwoods.
- Control gypsy moth on nearby hardwoods before planting and during Christmas tree growing cycle.



Gypsy moth egg mass on trunk.



Gypsy moth larva.



Female gypsy moths.



## Introduced Pine Sawfly

**Hosts:** Eastern white pine; less frequently Scotch, red, and Austrian pine.

**Importance:** Larvae consume the needles of Christmas trees. Lightly defoliated trees might be slightly degraded for a year or two, but heavily defoliated ones are usually unfit for sale. This insect is usually not abundant enough to cause injury because natural enemies and low winter temperatures keep it at tolerable levels.

### Look For:

- *Scattered patches of sparse or missing foliage* anywhere on the tree. Entire tree may be defoliated.

### JUNE-SEPTEMBER

- *Blackheaded larva*, up to 1 in. long, with yellow and white spots on a black background. It feeds alone or with a few other larvae in a loose cluster on the needles.
- *Brown cocoons*, about ¼ in. long, among the needles at the base of small branches or on the tree trunk.

**Biology:** Clusters of eggs are laid in slits in the needles from mid-May to mid-June, depending on locale. The larvae

hatch about 2 weeks later and feed in clusters for a short time before dispersing. They spin cocoons on the host in July and August. A second, overlapping generation usually follows and feeding occurs again into September in the Lake States and into November in the Central States. The second generation overwinters in cocoons on the tree.

**Monitoring:** Inspect white pines of all ages from June to September. Look for larvae or injury on 50 or more trees scattered throughout the plantation. Treat nurseries or young plantations (1 to 4 years) when you notice 5 to 10 larvae per tree. Treat older plantations when foliage injury becomes so obvious that degrade is likely.

### Control:

#### THIS CROP

- Spray heavily infested trees with a registered insecticide to control larvae. (See Pesticide Table.)

#### NEXT CROP

- Do not plant near sawfly-infested windbreaks or stands.
- If possible, plant eastern white pine away from other species.



Introduced pine sawfly larva.



Sawfly cocoon.

## Jack Pine Budworm

**Hosts:** Scotch, red, and Austrian pine.

**Importance:** Larval budworms defoliate trees and make them unfit for Christmas tree sale. Lightly defoliated trees recover after a few years, but heavily defoliated ones are degraded, attacked by other pests, or killed. Injury is most severe on trees that are beneath or next to large, infested host trees. This insect is usually important only within the range of jack pine in the Northern Lake States.

### Look For:

#### JUNE-NOVEMBER

- *Defoliated shoot tips or branches with webbed clusters of brownish needles* attached to the twigs with silk. Most of the webbed needles wash off the tree by winter.

#### MID-MAY–EARLY JULY

- *Larvae*, up to 1 in. long, feeding in the webbed foliage. Each has a black head and a brown body when young. When mature, the body is reddish-brown with small, cream-colored spots along the sides.

#### MID-JULY–MID-AUGUST

- *Tan or brown pupae or pupal skins* within the webbed foliage.
- *Green egg masses* on the undersides of needles.

**Biology:** Jack pine budworms overwinter on the tree as small larvae. In spring, larvae crawl to other parts of the host or are windblown to new hosts. They feed on needles and opening buds and attach the uneaten portions of the needles to the shoots with silk. When concealed in these clusters of webbed needles, budworms are difficult to control. The budworm's parasitic enemies usually cannot keep the population at a satisfactory level.

**Monitoring:** Inspect trees of all ages in mid-May when the shoots first begin to expand. Examine 1 shoot on each of 25 to 50 trees. Treat entire plantation if you find an average of 1 to 2 budworms per 10 shoots.

### Control:

#### THIS CROP

- Spray trees with Bt (*Bacillus thuringiensis*) after larvae emerge in May or June. (See Pesticide Table.)



## Pine Chafer (Anomala Beetle)

- Or, thoroughly spray trees with a registered insecticide when most of the larvae emerge in the spring. Spray when they are abundant—usually the first to third week in June. Repeat spray 7 to 10 days later if needed. (See Pesticide Table.)
- Do not ship infested nursery stock or trees because overwintering budworms “hitchhike” to new areas this way.

### NEXT CROP

- Plant only pest-free nursery stock.
- Plant trees at least 500 ft away from budworm-infested windbreaks or stands.

**Hosts:** All pines.

**Importance:** Adult pine chafers damage new, emerging needles by gnawing through needle sheaths. Old needles and some bark tissues are eaten after most of the new needles are destroyed. Affected needles turn brown and drop, leaving a ragged display of shoots that degrades the trees.

### Look For:

JUNE-SEPTEMBER

- **Broken, green or brown needles.** Heavily injured trees may look scorched in July because of brown needles. After August, the needles are short and have ragged ends.
- **Robust beetles**,  $\frac{1}{3}$  in. long, feeding on the shoots from mid-June to late July. The female beetle is tawny or buff; the male is brown with a greenish-bronze head.

**Biology:** Female beetles lay eggs in the soil of grassy areas near trees. The larvae feed only on grass roots, and do not harm the trees. Adults emerge from the soil and begin feeding on shoots in June and July, depending on location.

**Monitoring:** Examine trees of all ages regularly in June and July. Treat entire plantation if 5 percent of the needles on trees within 3 years of harvest are broken or discolored. On younger trees, treat if 20 percent of their needles are injured.

### Control:

THIS CROP

- Shear to remove some of the injured foliage, and the tree will outgrow the rest of the injury in 2 to 3 years.
- If control is needed, spray the trees once with a registered insecticide in late June when most of the beetles are feeding on the trees, but before they cause much injury. Apply the insecticide a week or so earlier if the beetles are abundant. (See Pesticide Table.)

NEXT CROP

- Reduce grasses in surrounding areas before planting.



*Defoliated shoot tips with webbed needles.*



*Jack pine budworm larva.*



*Jack pine budworm pupae on webbed foliage.*



## Pine Tube Moth



**Host:** Eastern white pine.

**Importance:** Pine tube moth larvae bind a few needles together into a tube and feed on the needle tips. This injury is cosmetic and usually insignificant.

### Look For:

- *Tubular clusters of 5 to 20 needles* bound with silk and squared off at the tips. Break the tubes open to find a yellow-green larva or pupa, up to ½ in. long.

**Biology:** The pupae overwinter in the tubes and become small moths in spring. Female moths disperse and lay eggs on needles, producing two generations during the summer. Natural enemies can usually keep the population in check.

**Monitoring:** Begin checking 2 years before harvest, in fall, winter, or early spring. Treat entire plantation only if tubes become obvious enough to degrade trees.

### Control:

#### THIS CROP

- When practical, clip off and destroy tubes to kill the larvae or pupae.
- Do not ship infested Christmas trees because overwintering pupae "hitch-hike" to new areas this way.
- To control first-generation larvae, apply a registered insecticide between mid-May and mid-June while tubes are being formed. (See Pesticide Table.)
- Or, apply a registered insecticide in mid-to-late July to control second-generation larvae.



*Tubular cluster of needles bound with silk and squared off at the end.*

## Pine Tussock Moth



**Hosts:** Eastern white and red pine; occasionally spruce and balsam fir.

**Importance:** Pine tussock moth larvae are heavy feeders and can readily strip the needles from any size Christmas tree. Needleless trees die and partially defoliated ones cannot be sold as Christmas trees. Generally, this insect has only been a problem in Wisconsin and Minnesota, although it occurs throughout the Northeastern United States.

### Look For:

- *Missing needles and ragged needle clumps* on some branches or on entire tree. Check for pellets of insect waste on the ground beneath trees to be sure needles were eaten and have not merely fallen off.

MAY–EARLY JULY

- *Light-brown or reddish-brown caterpillars*, up to 1½ in. long, with four prominent tufts of gray hair on their backs.

JULY–SEPTEMBER

- *Gray-brown, hairy cocoons or whitish egg masses*, about 1½ in. long, attached to needles.

Pests that cause similar symptoms: Redheaded pine sawfly, p.45.

**Biology:** Larvae overwinter at the base of the needles or under the bark of the host, and feed on needles during the spring. Feeding peaks in late June as the larvae mature. The insects then pupate and lay eggs on the remaining needles. Larvae hatch in summer.



*Missing needles.*



*Broken, green or brown needles.*



*Female and male pine chafers on shoot.*



## Redheaded Pine Sawfly

**Monitoring:** Examine trees of all ages from May through early July, looking for feeding larvae and/or injured needles. Treat entire nursery or plantation as soon as you notice larvae.

### Control:

#### THIS CROP

- Apply Bt (*Bacillus thuringiensis*) in mid-August or late April to control feeding larvae. (See Pesticide Table.)
- Or, apply a registered insecticide to the trees in late April or early May as the weather warms to control emerging larvae before extensive feeding occurs. (See Pesticide Table.)

- As an alternative, apply Bt or a registered insecticide in early to mid-August to control hatching larvae. (See Pesticide Table.)

- Do not ship infested Christmas trees because overwintering larvae may emerge in the warmth of a home and feed on the tree during the holiday.

#### NEXT CROP

- Avoid planting pine, spruce, or fir near infested trees, especially infested jack pine, the insects' preferred host.

**Hosts:** Red, Scotch, and Virginia pine; occasionally spruce, if planted with pine.

**Importance:** Larval colonies strip the needles from Christmas trees, killing branches, tree tops, or whole trees. Heavily defoliated Christmas trees are unfit for sale. This insect becomes an important pest every 10 to 12 years, causing injury for 2 or 3 years before subsiding. It prefers trees weakened by poor soil, drought, or competition from other plants.

### Look For:

- *Sparse foliage on shoots or branches* anywhere on the tree. Entire tree may be defoliated.

JUNE AND AUGUST (CENTRAL STATES) OR JULY (LAKE STATES)

- *Tufts of dry, straw-like needle remains* from feeding on new growth.

JUNE-OCTOBER (CENTRAL STATES) OR JULY-SEPTEMBER (LAKE STATES)

- *Yellow, black-spotted larvae* up to 1 in. long, with red heads, found in clusters on the foliage.

Pests that cause similar symptoms: Pine tussock moth, p.44.

**Biology:** The redheaded pine sawfly found in the Lake States usually has one generation, while those in the Central States may have two or more. Pupae overwinter in cocoons spun in the litter or topsoil. Adults emerge in June in the North and May and July farther south. Each female deposits 100 to 120 eggs in clusters on the needles; in 3 to 5 weeks, hatched larvae begin to feed in groups. One larval colony of 100 larvae can completely defoliate a 2-ft-tall tree; 15 to 20 larval colonies can completely defoliate a 6-ft-tall tree. Larvae feed for only 5 or 6 weeks, except in areas where a second generation is produced in the same season. In these areas, the second generation may completely defoliate and kill trees. After feeding, full-grown larvae drop to the soil and spin cocoons.

**Monitoring:** Begin checking trees of all ages in June and continue through September (Lake States) or October (Central States). Treat individual trees as soon as you notice colonies. Treat entire nursery or plantation when larvae are too abundant to control by hand methods.



*Pine tussock moth larva.*



### Control:

#### THIS CROP

- Knock occasional, scattered colonies of larvae off and crush them.
- If available, apply a registered virus in solution to young larvae.
- Or, apply a registered insecticide solution directly to the larvae. (See Pesticide Table.)

- Control competitive plants, particularly bracken fern, with herbicides to increase tree vigor. (See "Weeds, broad-leaved" in Pesticide Table.)

#### NEXT CROP

- Destroy dense weeds and bracken fern with herbicides before replanting. (See "Weeds, broad-leaved" in Pesticide Table.)
- Do not plant trees on dry, poor soils.



*Sparse or missing foliage on shoots and branches.*



*Redheaded pine sawfly larvae.*

## Spruce Budworm

**Hosts:** All spruces and firs; occasionally pines growing with spruce.

**Importance:** Budworm larvae defoliate trees, making them unfit for Christmas tree sale. Lightly defoliated trees recover after a few years, but heavily defoliated ones are degraded, attacked by secondary pests, or killed. Injury is most severe on trees that are beneath or next to large, infested host trees. This insect is usually important only within the spruce-fir range in the northern Lake States.

### Look For:

JUNE-NOVEMBER

- *Defoliated shoot tips or branches with webbed clusters of brownish needles* attached to the twigs with silk. Most of the webbed needles wash off the tree by winter.

MID-MAY-EARLY JULY

- *Larvae*, up to 1 in. long, feeding in the webbed foliage. Each has a black head and a light-brown body when young. When mature, the body is gray-brown with small, cream-colored spots along the sides.

MID-JULY-MID-AUGUST

- *Green egg masses* on the undersides of needles.

**Biology:** Spruce budworms overwinter on the tree as small larvae. In spring, they crawl to other parts of the host or are windblown to new hosts. They feed on needles and opening buds and attach the uneaten portions of the needles to the shoots with silk. When concealed in these clusters of webbed needles, budworms are difficult to control. The budworm's parasitic enemies can seldom keep the population at a satisfactory level.

**Monitoring:** Inspect trees of all ages in May when buds first begin to expand. Examine 1 bud on each of 25 to 50 trees. For trees that will be harvested within 3 years, treat entire plantation when you find an average of: 1 to 2 larvae per 10 *spruce* buds; or, 1 to 2 larvae per 20 *fir* buds. For young trees, 4 or more years from harvest, treat entire plantation when you find an average of: 2 to 4 larvae per 10 *spruce* buds; or, 1 to 2 larvae per 10 *fir* buds.

Photo by Daniel G. Mosher, Michigan Department of Natural Resources.



## Spruce Needleminers

### Control:

#### THIS CROP

- Spray trees with Bt (*Bacillus thuringiensis*) after larvae emerge in mid-May. (See Pesticide Table.)
- Or, thoroughly spray trees with a registered insecticide after most of the larvae emerge in May. Repeat spray 7 to 10 days later if needed. (See Pesticide Table.)
- Do not ship infested nursery stock or trees because overwintering budworms "hitchhike" to new areas this way.

#### NEXT CROP

- Plant only pest-free nursery stock.
- Plant trees at least 500 ft away from budworm-infested windbreaks or stands.

Photo by Gary A. Simmons



Defoliated shoot tips.



Budworm larva on needles.



Green egg masses under needles.

**Hosts:** All spruces.

**Importance:** Larval needleminers tunnel into the needles of spruce Christmas trees. They cut and web needles into small, unsightly nests that mar the trees' beauty. Lightly infested trees recover in 2 to 3 years, but heavily infested ones are unfit for sale and may die. The green spruce leaf miner and the spruce needleminer are the two most common needle-mining pests of spruce.

### Look For:

- *Small clusters of discolored needles webbed tightly together* and flattened against the branch. Small trees may be injured anywhere on the crown. The webbing on larger trees is mostly on the inner parts of the lower branches.
- *Hollowed-out needles, with a small hole usually near the base* of each needle.

JUNE—MID-APRIL

- *Brown, gray, or reddish larvae*, up to ¼ in. long, in the needles or within webbed foliage.

**Biology:** Immature larvae overwinter in nests of hollowed-out needles and waste held together with silk. They feed for a few weeks in spring and then pupate. Adults begin emerging between mid-May (Central States) and mid-June (Lake States) and lay eggs on the needles. In about 2 weeks, larvae hatch and begin mining needles. As they grow, they hollow out, cut, and web the needles together to form a nest-like enclosure.

**Monitoring:** Inspect trees of all ages anytime during growing season. Treat entire nursery or plantation if you notice any injury on trees within 3 years of harvest. On younger trees, treat when 25 percent of the needles show damage.

### Control:

#### THIS CROP

- Spray trees thoroughly with a registered insecticide in mid-June (Central States) or mid-July (Lake States) to control larvae just after they emerge from the eggs. A repeat spray 10 to 14 days later may help. (See Pesticide Table.)
- Or, spray trees in spring after larvae begin feeding again. Repeat 10 to 14 days later if needed.

- Do not ship infested Christmas trees or nursery stock because overwintering larvae "hitchhike" to new areas this way.

#### NEXT CROP

- Plant only pest-free nursery stock.
- Do not plant near infested spruce.



Cluster of discolored, webbed needles.



Hollow needle with a hole near its base.



Spruce needleminer larva.

Photo by Mark E. Ascerno, University of Minnesota.



## Webworms

**Hosts:** All pines; eastern redcedar.

**Importance:** Webworm larvae can kill or stunt Christmas tree seedlings by eating all the needles off the branches. Their unsightly, webbed nests also reduce tree quality. Webworms on eastern redcedar are usually a more serious problem than those on pines. Important nest-building webworms are the pine webworm, the pine false webworm, and (the most destructive of these pests) the juniper webworm.

**Look For:** (On pine)

■ *Conspicuous, elongate, or globelike nest*, 2 to 6 in. wide, made of brownish needles and pellets of insect waste spun together with webbing. Needles near the nest have been chewed off.

MAY-JUNE

■ *Green larvae*,  $\frac{3}{5}$  to  $\frac{7}{8}$  in. long, with 3 pairs of legs, in the nest.

JULY-AUGUST

■ *Yellow-brown larvae*,  $\frac{3}{5}$  to  $\frac{7}{8}$  in. long, with 8 pairs of legs, in the nest.

**Look For:** (On eastern redcedar)

■ *Brownish nests*, 2 to 3 in. long, made of webbed shoots. Needles near the nest have been chewed off.

SEPTEMBER-EARLY JUNE

■ *Several light-brown larvae*,  $\frac{1}{2}$  in. long, in the nest.

**Biology:** These heavy feeders build waste-filled nests and enlarge them as they feed on needles and develop. Depending upon species, a few to more than 70 larvae may inhabit a single nest.

**Monitoring:** Examine trees of all ages and treat when nests are too numerous to destroy by hand. If you find mined needles on new growth of eastern redcedar during the summer, treat entire nursery or plantation next spring.

### Control:

#### THIS CROP

- Clip and/or destroy nests if they are few and scattered.
- Or, spray trees with a registered insecticide whenever larvae are feeding and building nests. (See "Webworms" in Pesticide Table.)
- Spray for pine false webworm (green larvae in a nest on pine) in May or June.
- Spray for pine webworm (yellow-brown larvae in a nest on pine) between July and August.

- Spray for juniper webworm (brownish larvae on eastern redcedar) in April or May when the weather warms for best control.
- Do not ship infested eastern redcedar because webworms "hitchhike" to new areas this way.

#### NEXT CROP

- Plant only pest-free nursery stock.



Webworm nest.



Pine false webworm larva.

Photo by Daniel G. Mosher, Michigan Department of Natural Resources.

Photo by Daniel G. Mosher, Michigan Department of Natural Resources.



## Shoot/Branch Injury



Needles on shoots or branches uniformly discolored—usually red, yellow, or brown. Foliage may be black from sooty mold fungus. Frothy spittlemasses, aphid colonies, or scales may be on bark. If needles on shoots are cut off and webbed together, see previous section. If galls are present, see next section.









## Adana Tip Moth

**Hosts:** Scotch, Austrian, red, and Virginia pine.

**Importance:** The larvae of this moth bore into the buds and developing shoots of seedlings and Christmas trees. This kills and deforms shoots, stunts growth, and degrades trees. Adana tip moth is most commonly carried into plantations or infested nursery stock.

### Look For:

- *Dead and dying, stunted* or stubby shoots anywhere on the tree or seedling. Shoots are killed before the needles fully expand.
- *Small hole at the base of the dead shoot.*

### MAY-JUNE

- *Yellowish to reddish-brown, black-headed larvae*, up to  $\frac{3}{8}$ " long, on or inside the new shoot.

### AUGUST-APRIL

- *Pupae in soil-covered cocoons* attached to the root collar of the tree (where the mainstem and the roots meet, under the soil).

Pests that cause similar symptoms: Diplopedia shoot blight, p. 54; European pine shoot moth, p. 56.

**Biology:** Adult moths emerge in April as the weather warms, and the females lay their eggs on the needles. Hatching larvae soon bore into and mine (hollow out) needles near the bud. By early June, larvae leave the needles and tunnel into developing shoots, killing the shoots before they fully elongate. This insect overwinters as a pupa in a cocoon attached to the root collar of the tree.

**Monitoring:** Inspect trees of all ages when shoots begin to expand in April or May. Treat entire plantation when injury becomes too extensive to control with

normal shearing. For seedlings or trees that are too small to shear, consider treating if 10 percent or more of the trees are injured.

### Control:

#### THIS CROP

- Shear off and destroy crooked, injured leaders and shoots before June to restore trees to good form.
- Spray trees or seedlings with a registered insecticide in mid- to late April to kill emerging larvae. Repeat if needed in late May or early June. (See Pesticide Table.)
- Do not ship infested nursery seedlings in fall or spring because the pupae "hitchhike" to new areas this way.

#### NEXT CROP

- Plant only pest-free nursery stock.



Dead, stunted shoots on seedlings.

Inset: Soil-covered cocoon attached to root collar.



## Aphids

**Hosts:** All Christmas tree species.

**Importance:** Aphids suck juices from branches, shoots, and needles of Christmas trees. Affected trees lose their needles, attract secondary pests, and become unfit for Christmas tree sale. The spotted pine aphid is one of the most common aphids on pine Christmas trees.

### Look For:

- **Discolored, sparse foliage anywhere on the tree.** Scattered groups of needles turn yellow or red in summer and drop off in fall. Surrounding foliage may look sooty and glisten as if lacquered. Bees and ants may be abundant on the foliage.

MAY-NOVEMBER

- **Small, winged or wingless insects** clustered on the shoots or needles. They are yellow-green, brown, or black, and about  $\frac{1}{8}$  in. long. (The spotted pine aphid, which is greenish with black spots, grows to  $\frac{1}{4}$  in. long.) Some species are naked, and others are covered with a woolly wax. (See pine bark aphid, p. 79.)

**Biology:** Most aphids overwinter on the trees as eggs. Nymphs hatch in spring and quickly mature and reproduce. Several overlapping generations can produce large populations by late summer. Droughty weather at this time will increase needle fall. Applying nitrogen fertilizers when trees are young tends to increase aphid numbers.

**Monitoring:** Begin checking trees 2 years before harvest, starting in mid-summer and continuing regularly until frost. Control may not be needed in the years before harvest if lady bugs and other predators are abundant. Treat individual, infested trees only if more than 30 percent of the shoots have aphid colonies. However, in a harvest year, treat all infested trees before cutting.

### Control:

#### THIS CROP

- Spray trees with a registered insecticide to control large aphid populations. (See Pesticide Table.)
- Wash off black discoloration caused by sooty mold by spraying affected tree parts with a solution of 4 oz liquid detergent in 100 gal of water. Apply under high pressure in late afternoon, leave overnight, and then rinse trees with water the next morning.



Discolored foliage.

- Do not ship infested trees or nursery stock because overwintering aphid eggs "hitchhike" to new areas this way.
- Limit the use of broad-spectrum insecticides that kill helpful aphid predators.
- Control mound ant colonies; these ants protect aphids by discouraging the natural enemies of aphids. (See Allegheny mound ant, p.77.)

#### NEXT CROP

- Plant only pest-free nursery stock.



Spotted pine aphid on needle.

Photo by David J. Shellar, Pennsylvania State University



White pine aphids on stem.



Aphids covered with woolly wax.

Photo by Daniel G. Mosher, Michigan Department of Natural Resources.



## Cytospora Canker

**Hosts:** Spruces, especially Colorado blue and Norway.

**Importance:** This fungus usually infects trees older than 15 years that are stressed by drought, winter injury, or other diseases. Branch cankers degrade trees by killing foliage and branches. Stem cankers can eventually kill trees.

### Look For:

- **Brown needles on lower branches.** Dead needles may drop off immediately or stay on the tree for up to a year. Cytospora canker gradually kills lower branches, then spreads to higher branches.
- **Large, white patches of pitch** at canker sites. Cankers are hard to spot because the bark looks normal. Use a hand lens to find tiny, black fruiting bodies in the bark above the canker. Cut away bark to see the dead, brown areas of the inner bark.

Factors that cause similar symptoms:  
Drought, p. 26.

**Biology:** Spores ooze from the fruiting bodies in threadlike masses during wet weather and are spread by rain, wind, and cultural activities such as pruning. The fungus infects stressed trees through wounds or dead areas.

**Monitoring:** Inspect old trees, especially those 15 years or older. Look for brown needles on dead, lower branches at any time of year. Treat individual trees as soon as you notice injury.

### Control:

#### THIS CROP

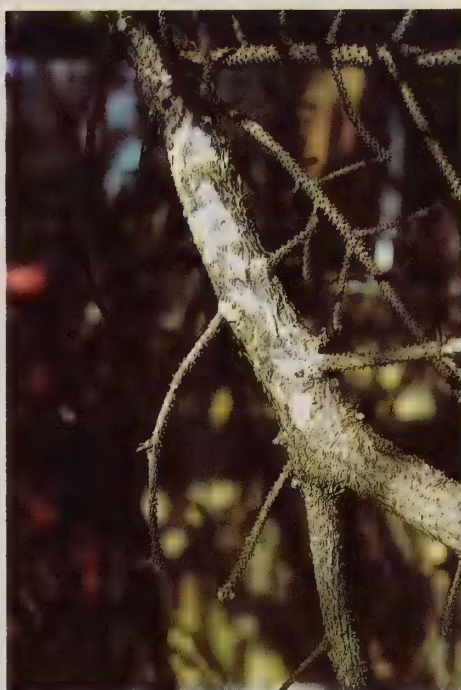
- Remove infected branches. Do not prune or shear infected trees during wet weather because spores released at this time may be carried from tree to tree on pruning tools.
- Improve tree vigor through cultural practices such as fertilization and weed control.
- Sell trees growing on poor sites as soon as possible if Cytospora has been a problem in your plantation. These trees are more likely to be infected than those growing on good sites.
- Avoid wounding trees because wounds are entry points for the fungus that causes Cytospora canker.

#### NEXT CROP

- Do not plant susceptible species on poor sites.
- Take preventive measures as described above to protect new foliage.



*Brown needles on lower branches.*



*White patches of pitch at canker site.*

## Deer

**Hosts:** All pines.

**Importance:** Deer feed on the shoots of young pines. In large numbers, these animals can cause great damage to pine plantings. Heavily browsed trees may be too deformed to be sold as Christmas trees.

### Look For:

- **The rough, squared-off ends of deer-browsed twigs**, ½ in. or less in diameter, on the lower 6 ft of the tree. Shredded bark and wood may hang from cut twigs.
- **Deer droppings and tracks** near trees.
- **Strips of shreaded or damaged bark on stems** of large seedlings and saplings. Deer may rub the bark off when polishing their antlers against stems in early fall.

Pests that cause similar symptoms:  
Rabbit and hare, p. 81.



*Deer-browsed branches on lower half of tree.*



## Diplodia Shoot Blight And Canker

**Monitoring:** Examine trees of all ages throughout the year, especially during winter. If 5 to 10 percent of the trees are injured, contact a conservation officer or a wildlife pest control specialist to help determine if control is appropriate under local conditions. No control is needed if injury is random and infrequent.

### Control:

#### THIS CROP

- When appropriate, use a deer repellent for some degree of control. Keep in mind that deer control is difficult and often ineffective. (See Pesticide Table.)

#### NEXT CROP

- Avoid planting where deer are known to congregate during the winter.



Deer may rub the bark off when polishing their antlers.

**Hosts:** Red, Scotch, and Austrian pine.

**Importance:** This fungus kills current-year shoots on trees of all ages, and usually kills nursery seedlings within the first year. Repeated infection over several years eventually kills old trees. Girdling cankers are formed when Diplodia infects wounds on the stem and branches.

### Look For:

- *Stunted or curled, current-year shoots.* Infected tissue will be resin-soaked.
- *Black fruiting bodies* on dead needles or shoot tissue.
- *Cankers--oblong, sunken areas* on branches or stem. The top of the tree above girdling cankers will be killed.
- *Olive-green streaking* on the resin-soaked tissue beneath the bark.

Pests that cause similar symptoms: drought, p. 26; pales weevil, p. 59; pine root tip weevil, p. 61; spittlebugs, pp 62,64. If shoots are hollow: Adana tip moth, p. 51; European pine shoot moth, p. 56; Nantucket pine tip moth, p. 58. Canker: scleroderris canker, p. 65.

**Biology:** Diplodia overwinters in pine shoots, bark, cones, or litter and infects growing shoots in the spring. Spores are released during wet weather from spring through fall. Trees that are stressed because of poor sites, drought, snow damage, or insect activity are very susceptible to this disease. Wounds, such as those made by hail, shearing, or insects, serve as entry points for Diplodia. For instance, this fungus frequently infects trees that have been wounded by pine spittlebug feeding.

**Monitoring:** Inspect trees of all ages in late spring or early summer. Randomly select 50 or more trees scattered throughout the plantation and look for stunted or curled, current-year shoots. If more than 10 percent of these trees are unsalable because of Diplodia, consider treating the entire plantation next spring. Take other preventive measures immediately to avoid spreading the disease.

### Control:

#### THIS CROP

- Control insects that are weakening trees and creating entry points for Diplodia.
- Do not shear infected trees during wet weather because spores released at this time may be carried from tree to tree on shearing tools.
- Apply a registered, preventive fungicide four times, once every 2 weeks during shoot elongation to prevent shoot blight from spreading to healthy trees. (See Pesticide Table.)

#### NEXT CROP

- Plant pest-free stock.
- Avoid planting susceptible species as Austrian or red pine on poor sites where they will be more vulnerable to both insect and fungal attack.
- Do not plant trees next to windbreaks that are infected with Diplodia. Examine windbreaks closely; although shoots may not be infected, cones may still harbor Diplodia.
- Take preventive measures as described above to protect new foliage.



Stunted or curled, current-year shoots.



## Eastern Pine Shoot Borer



Diplodia fruiting bodies on dead needles.



Dead tree tops.

**Hosts:** All pines; white spruce; Douglas-fir.

**Importance:** The larvae of this small moth usually attack new lateral (side) shoots on the top branches of the tree. When abundant, larvae can ruin the general shape of the crown by killing many shoots.

### Look For:

JUNE-OCTOBER

- **Flagged (discolored) shoots** on pine and spruce. The 6- to 8-in.-long ends of shoots turn yellow and then red. Douglas-fir shoots wilt and droop before yellowing, curling into the shape of a shepherd's crook. (Do not confuse shepherd crooking with white pine weevil injury, which looks similar, but occurs on the terminal (topmost) shoot and down to the stem below the first whorl of branches.)
- **Terminal leaders or large branch ends broken over near their bases**, leaving distinctive, flat stubs.
- **An oval hole at the base of the injury** through which the larva has escaped.
- **Hollowed-out center of the injured shoot.** Verify by cutting shoot lengthwise with a knife. If cut before mid-July, you may find a dirty white-to-gray larva, up to  $\frac{3}{4}$  in. long, in the shoot.

**Biology:** Female moths emerge in May and lay eggs on the new shoots. Young larvae bore into elongating shoots and hollow out the center as they grow. After chewing a hole at the base of the injury, mature larvae emerge and drop to the ground to pupate and overwinter.

**Monitoring:** Examine trees of all ages from mid-summer to frost. If you find more than 10 injured shoots per tree when trees are 2 or 3 years from harvest, treat entire plantation next spring.

### Control:

THIS CROP

- Shear to remove some injured shoots, and corrective prune forked trees by removing excess terminals. You may want to touch-up affected trees before marketing.

- Apply a registered insecticide to trees in mid-May to kill larvae before they bore into shoots. (See Pesticide Table.) Do not delay treatment. By the time injury is apparent, most larvae have left the shoots, and control will not be effective.

### NEXT CROP

- Plant resistant varieties of Scotch pine such as Swedish, Riga, or Scandinavian. (See table on p. 11 for resistance rankings of Scotch pine.)



Flagged, crooked shoots.



Oval "exit" hole at base of injury.



## European Pine Shoot Moth

**Hosts:** Scotch, red, and Austrian pine.

**Importance:** The larvae of this moth bore into the buds and developing shoots of Christmas trees. This kills or deforms shoots, stunts growth, and makes Christmas trees unfit for sale.

### Look For:

- **Dead, stunted, or stubby shoots** anywhere on the tree. Shoots usually die before needles expand.
- **Hardened globs of pitch** where larvae have bored into shoots.
- **Distorted, bushy, or multileadered trees.**

MID-APRIL–EARLY JUNE

- **Brownish, blackheaded larvae**, up to  $\frac{5}{8}$  in. long, on or inside new shoots.

Pests that cause similar symptoms: Adana tip moth, p. 51; Diplodia shoot blight, p. 54; Nantucket pine tip moth, p. 58.

**Biology:** In the spring, larvae bore into healthy shoots to feed and pupate. New adults emerging in June and July produce larvae that bore into needles and buds to overwinter. During particularly cold winters, only larvae that are insulated on branches below the snowline will survive. Dry weather and poor soil conditions encourage population buildup.

**Monitoring:** Inspect trees of all ages in April and May. Randomly select 30 to 50 trees scattered throughout the plantation and look for larvae and injury. Consider treating entire nursery or plantation if 10 percent or more of the young trees are injured or if the older trees average more than five injured tips per tree. Treat for any amount of injury if trees are to be harvested this year.

### Control:

#### THIS CROP

- If attacks are light and scattered, prune and destroy injured shoots before June.
- Wait to shear trees until mid-July when shearing will remove most of the eggs or larvae on shoot tips.
- Prune crooked, injured leaders and branches while shearing to restore trees to good form.

- Remove the lower whorl(s) of branches from your best Christmas trees to prevent larvae from overwintering below the snowline and surviving. This will also give the trees "handles" and make harvesting easier.

- Do not ship infested nursery stock or Christmas trees because overwintering larvae "hitchhike" to new areas this way.

- Spray trees with a registered insecticide in the first 2 weeks of April to kill larvae as they migrate to new shoots. And/or treat trees in late June or early July after larvae hatch from the eggs. (See Pesticide Table.)

#### NEXT CROP

- Plant only pest-free nursery stock.



Distorted growth.



Dead, stunted shoot.



Hardened glob of pitch on shoot. Note larva.



European pine shoot moth adult.

Photo by David J. Sheller, Pennsylvania State University



## Frost Injury

**Hosts:** Balsam fir; Douglas-fir, spruce; occasionally pine.

**Importance:** Below-freezing temperatures in early spring can kill emerging shoots and degrade Christmas trees. Susceptible trees may become stunted or bushy if injured by frost several years in a row.

### Look For:

MAY-JUNE

- *Brown, wilting and dying shoots* of the current year's growth. New shoots will develop next to the dead ones.
- *Live, crooked shoots.*

AUGUST-OCTOBER

- *Dead shoots remaining on trees* until late autumn. They may not drop until spring.



*Brown, wilting and dying shoots.*

Pests that cause similar symptoms: White pine weevil, p. 68, damages tops only.

**Monitoring:** Examine trees of all ages after a late spring frost. Take recommended actions if any noticeable damage occurs.

### Control:

THIS CROP

- Remove dead shoots when shearing.
- Harvest trees growing in "frost pockets"—low areas where damaging frost frequently occurs—as soon as possible and replace them with more resistant pine species.

NEXT CROP

- Do not plant susceptible species in "frost pockets".

## Jack Pine Tip Beetle

**Hosts:** Scotch and red pine.

**Importance:** The larvae of this small beetle kill terminal (top) and lateral (side) shoot tips by feeding on the inner bark. Dead shoot tops fall off the tree by autumn, producing a harmless effect similar to shearing. Trees may be degraded by forking if two or more lateral buds develop and become leaders. The problem occurs mostly when Christmas trees are planted next to a jack pine stand.

### Look For:

MAY-OCTOBER

- *Yellow or red shoot tips*, mostly toward the top of the tree. The top 1 in. of the tip dies and leaves a flat stub where broken off.
- *A small pitch tube*—glob of pitch with a hole in it—about 1/2 in. behind the bud.
- *A dark-brown beetle*, about 1/16 in. long, or several smaller, white larvae inside the injured tip. Peel away the bark of the tip to find the insect.

**Monitoring:** Inspect trees 2 years before harvest, and treat during regular shearing.

### Control:

THIS CROP

- Shear injured tips during routine trimming. Injured tips missed in shearing will probably fall off naturally.
- Prune excess leaders to prevent forking.

NEXT CROP

- Avoid planting susceptible pines within 50 ft of jack pine.



*Pitch tube below the bud.*



## Nantucket Pine Tip Moth

**Hosts:** Scotch, Austrian, Virginia, and red pine.

**Importance:** The larvae of this moth kill and deform shoots of nursery and plantation Christmas trees. The trees become bushy and misshapen and are therefore degraded as Christmas trees. This pest occurs mainly in the southern portions of the North Central Region.

### Look For:

- *Dead or dying new shoots with expanded needles* anywhere on seedlings or trees.

MID-MAY – AUTUMN

- *Brown to orange larvae*, up to  $\frac{3}{8}$  in. long, on or inside new shoots.
- *Small, tentlike webbing* on surface of needles or at base of shoots.

Pests that cause similar symptoms: Diplodia shoot blight, p. 54; European pine shoot moth, p. 56.

**Biology:** Pupae overwinter in hollowed-out shoots. Adult moths emerge in April when the weather warms and lay eggs on the shoots. Newly hatched larvae feed on new, expanding shoots under small, tentlike webs, and then pupate 3 to 4 weeks later. One or two generations follow. Dry weather and poor soil conditions encourage population buildup.



Dead shoots with expanded needles.

**Monitoring:** Examine trees of all ages, especially in nurseries and during the first 5 years after planting. Check closely in mid- to late April, and treat entire nursery or plantation if you find any injury.

### Control:

#### THIS CROP

- If the attack is light and scattered, prune and destroy the injured shoots.
- Shear when larvae are feeding to remove infested shoots.
- Thoroughly drench shoot tips with a registered insecticide between mid-May and mid-June (timing depends on latitude) to control young larvae before they conceal themselves. You may need to treat again between mid-July and late August to control additional generations of larvae. (See Pesticide Table.)
- Do not ship infested nursery seedlings or Christmas trees because overwintering pupae "hitchhike" to new areas this way.

#### NEXT CROP

- Plant only pest-free nursery stock.



Nantucket pine tip moth larva inside shoot.

## Northern Pine Weevil

**Hosts:** All pines and spruces.

**Importance:** This insect causes minor damage in Christmas tree plantations where weak or dead pines are left standing, or where many fresh stumps are available for weevil breeding. Heavy feeding by adults may kill some shoots, leaving dead spots in the crown and slightly degrading Christmas trees. Heavy feeding may kill seedlings.

### Look For:

- *Flagged (discolored and deformed) shoot tips* anywhere on trees or seedlings.

- *Small, circular feeding wounds* ("drill holes") at the base of injured shoots. Pitch may ooze from the wounds.

- *Small, white pupae or C-shaped larvae*,  $\frac{1}{3}$  in. long, beneath the bark of dead trees or stumps.

- *Elliptical chambers in the wood* beneath the bark, each covered with a  $\frac{1}{2}$ -in.-long chip cocoon, made of fine wood shavings.

- *Light-brown, white-spotted weevils*,  $\frac{1}{3}$  in. long, feeding on pine shoots after dark.

Pests that cause similar symptoms: Pales weevil, p. 59, causes more widespread damage by stripping off bark; Saratoga spittlebug, p. 64.

**Biology:** Female weevils lay eggs in the spring on the inner bark of stumps and recently dead or dying trees. Larvae mature under the bark and make chip cocoons to pupate in. After pupating in August, weevils emerge and feed on the inner bark of twigs and small branches. They overwinter in the litter around infested trees.

**Monitoring:** Inspect trees of all ages, especially where fresh stumps are available. In June, look for pitchy "drill holes" or flagged tips on seedlings or older trees. Treat entire nursery or plantation if seedlings show any injury or if older trees have five or more flagged tips per tree. Infestations lighter than this do not need control, because most flags will fall off before harvest.



### Control:

#### THIS CROP

- Remove dead or dying pines and fresh stumps before late spring to eliminate the weevils' breeding material.
- Or, in April to mid-May, drench fresh stumps and nearby soil once with a registered insecticide mixed in kerosene or fuel oil to kill the egg-laying adults. A similar drench in August will kill emerging adults. (See Pesticide Table.)
- Spray living trees once with a registered insecticide once in August or September to kill the feeding adults. (See Pesticide Table.)

- When harvesting, leave one whorl of live, pest-free branches on each stump to keep it alive and therefore unattractive to the weevils. Destroy these stumps within 3 years. Caution: Do *not* leave live branches that have needle-cast diseases.

#### NEXT CROP

- Delay replanting a cutover area for 2 years unless stumps are removed or treated to resist weevil attack.

**Hosts:** Eastern white and Scotch pine; Douglas-fir; occasionally other pines and some spruces.

**Importance:** This insect is a chronic problem in Christmas tree plantations where periodic harvests leave many pine stumps suitable for weevil breeding. The adults feed on the stem bark of seedlings and on the shoot and branch bark of older pines and other conifers. Seedlings die. Heavy feeding girdles and kills shoots, thereby thinning and degrading Christmas trees.

### Look For:

JUNE-AUGUST

- Dead seedlings.**
- Dead shoot tips** on large trees.
- Small, irregular patches of exposed wood** on seedling stems or at the bases of flagged shoots on large trees. Pitch may ooze from the wounds, or the scars may be partially calloused.
- White, C-shaped larvae or pupae**,  $\frac{1}{2}$  in. long, beneath the bark of the roots of fresh pine stumps. The insects are in chambers (galleries) that run along the grain of the wood. Remove root bark with a knife to see insects.
- Reddish-brown to black, robust weevils**,  $\frac{1}{3}$  in. long, under the litter around live trees and stumps. Adults are on the trees during warm nights (temperature above 50° F) from April to September. To locate them, put a sheet under the tree after dark and shake the tree. Weevils will fall onto the sheet. Or, bait the weevils in spring by placing freshly cut pieces of pine stem on the ground near the tree.

Pests that cause similar symptoms: Diplodia shoot blight, p. 54; Saratoga spittlebug, p. 64; white pine blister rust, p. 66. Pine root collar weevil, p. 79, and pine root tip weevil adults, p. 61, are nearly identical to pales weevil and have similar life cycles. Wood borers and bark beetles, p. 82, carve distinctive galleries in the stump collar *above* the pales weevil. Wood borers leave holes in the tops of old stumps.

**Biology:** Drawn by the odor of fresh pine resin in spring, female weevils lay eggs in the inner bark of new stumps. Larvae tunnel a few inches to several feet into the roots during the summer. Adults, emerging in late summer to early fall, spend the day in the litter around the trees and move onto trees at night to



Flagged shoot tip.



Northern pine weevil adult.

Northern pine weevil larvae (inset) are found in chip cocoons under the bark.

Photo by David J. Shelton



feed on the bark. Later in the fall, they move to the litter to overwinter. Pales weevil commonly occurs along with the northern pine weevil.

**Monitoring:** Examine trees of all ages in June, especially where fresh stumps are available. Examine 50 or more trees scattered throughout the plantation. Treat entire nursery or plantation if seedlings show any injury or if older trees average five or more flagged tips per tree.

#### Control:

##### THIS CROP

- Remove new stumps in early spring to eliminate the weevils' breeding material.
- Or, once between early April and mid-May, thoroughly drench the stumps and nearby soil with a registered insecticide mixed in kerosene or fuel oil to kill egg-laying adults. A similar drench in August will kill emerging adults. (See Pesticide Table.)
- Or, apply a registered insecticide to live trees between mid-August and mid-September when adults move onto trees to feed. (See Pesticide Table.)
- When harvesting, leave one whorl of live, pest-free branches on the stump to keep it alive and therefore unattractive to the weevils. Destroy these stumps within 3 years. Caution: Do *not* leave live branches that have needlecast diseases.

##### NEXT CROP

- Delay replanting a cutover area for 2 years unless stumps are removed or treated to resist weevil attack.
- Dip seedlings in a registered, residual insecticide before planting to prevent weevil feeding. (See Pesticide Table.)



*Pales weevil adult.*



*Patches of exposed wood and pitch.*



*Pales weevil larvae and pupae on stump roots.*



*Shoot tips killed by pales weevil.*



## Pine Grosbeak

**Hosts:** Scotch pine; occasionally white and red pine and spruce.

**Importance:** Pine grosbeaks feed on the buds of Christmas trees, stunting height growth and thinning crown foliage. This feeding causes dormant buds to develop into bushy clusters of shoots that deform and degrade trees. The extent of damage varies from year to year, depending on the number of birds and the supply of other food available during the winter months.

### Look For:

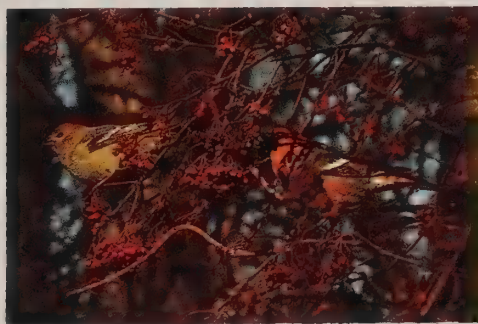
#### WINTER

- **The pine grosbeak**—A robin-sized bird with a large, cone-shaped beak. Adult males are grey with a rosy-red coloring in the crown, rump, and breast. In females, these areas are suffused with yellow.
- **Buds missing from the topmost shoot and the upper branches** of trees.

#### MAY-JULY

- **Bushy foliage in the upper part of the tree**, sprouting from lateral (side) buds that normally remain dormant.

**Biology:** During the winter months, when their normal food supply is depleted, grosbeaks may migrate from the northern forests south to areas that provide adequate food and shelter, such as Christmas tree plantations. Normally, this only happens once every 4 or 5 years.



Pine grosbeak adults.

**Monitoring:** Inspect trees within 2 or 3 years of harvest, and protect them if you notice flocks of grosbeaks daily during the winter.

### Control:

#### THIS CROP

- If practical, install an audio device to discourage flocking.
- Shear damaged trees to help restore good form.
- Place a plastic, mesh sleeve over the topmost shoot after the tree has become dormant, and remove it the following spring. This control is most practical for protecting high-value trees ready for harvest. Note: The pine grosbeak is protected by the Federal Migratory Bird Treaty Act.

#### NEXT CROP

- Plant resistant varieties of Scotch pine such as S. French, Poland, Belgian, or Czechoslovakia. (See table on p. 11 for resistance rankings of Scotch pine.)



Buds missing from topmost shoot

## Pine Root Tip Weevil

**Hosts:** Scotch and red pine; eastern white pine, if mixed with Scotch pine.

**Importance:** Larvae of this weevil feed on the root tips of Christmas trees, preferring trees grown from stumps (tip-ups) because of the large root systems on these second-crop trees. Injured Scotch or red pines become discolored and may die. White pine may be attacked if grown near susceptible pines, but few will be killed. This weevil is found mostly in the northern Lake States.

### Look For:

- **Flagged (deformed and discolored) shoots and branches** anywhere on the tree. Some trees may be dead.
- **Debarked, hollowed-out root ends** where root tips have been chewed off.
- **White, C-shaped larvae**, up to ½ in. long, which may be in the root.

Pests that cause similar symptoms: Diplodia shoot blight, p. 54; pine spittlebug, p. 62; Saratoga spittlebug, p. 64; scleroderris canker, p. 65. Pales weevil adults, p. 59, and pine root collar weevil adults, p. 79, are nearly identical to pine root tip weevil in appearance.

**Biology:** Larvae and adults overwinter underground. Adults emerge in April and lay eggs in June. Newly hatched larvae feed on the rootlets and then tunnel into the main lateral (side) roots as they grow. After overwintering, the larvae continue to root feed until July, when they pupate. New adults emerge in late summer.

**Monitoring:** If you suspect pine root tip weevil, ask a pest specialist for help in diagnosis. Treat if recommended.



Flagged shoots and branches.



## Pine Spittlebug

### Control:

#### THIS CROP

- Drench trees with an insecticide registered for weevils in late July or early August to kill adult weevils as they move onto trees to feed. This treatment has not been tried for pine root tip weevil, but has been found to control similar weevils. (See Pesticide Table.)

#### NEXT CROP

- Avoid growing trees from stumps (tip-ups).



Debarked, hollowed-out root with chewed-off tip.

**Hosts:** Scotch, Austrian, and white pine; all spruces and firs.

**Importance:** Spittlebug nymphs and adults suck sap from nursery and plantation Christmas trees. Unless abundant, they seldom do more than flag (discolor and deform) an occasional branch tip. However, Diplodia shoot blight, which invades weakened pines through spittlebug feeding wounds, may heavily flag or kill trees.

### Look For:

- *Flagged shoot tips* anywhere on the tree (especially on pines). Foliage may look sooty and glisten as if lacquered. Some trees may be dead.
- *One or more creamy-yellow to black nymphs*, up to 1/4 in. long, inside spittlemasses.

#### MAY—EARLY JULY

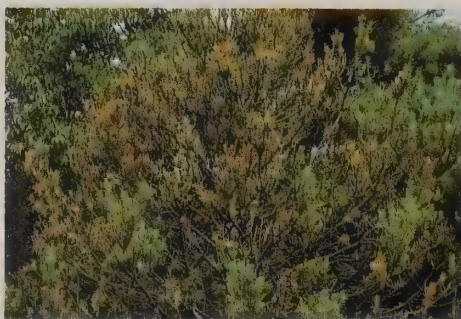
- *Frothy, white spittlemasses* on shoots or trunk.
- *Symptoms of Diplodia shoot blight* on pines (see p. 54).

#### MID-JUNE—MID-SEPTEMBER

- *Oval-shaped adults*, about 1/3 in. long, on needles or branches. They jump when approached or touched.

Pests that cause similar symptoms: Diplodia shoot blight, p. 54; pine root tip weevil, p. 61; Saratoga spittlebug, p. 64; scleroderris canker, p. 65.

**Biology:** Nymphs hatch in May from eggs laid under the bark of shoots. For the next 6 to 7 weeks, they feed on the tree's sap and produce the characteristic, frothy spittlemasses from partially digested sap. Black sooty mold grows on the sugary sap splashed from the spittlemasses. Adults appearing in July also suck the tree's sap, but form no spittlemasses. Diplodia shoot blight enters the feeding wounds and causes shoot tips to turn brown.



Flagged shoot tips.

**Monitoring:** Examine trees of all ages, especially those under stress, from May through June. A few, scattered spittlemasses need no treatment if trees are otherwise healthy. If insects seem abundant—as if trees are partially coated with “snow”—look for flagging in late summer and early fall. If trees are flagged, or if Diplodia shoot blight is also present, treat entire plantation next summer.

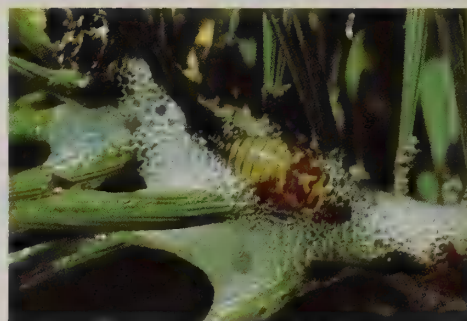
### Control:

#### THIS CROP

- Apply a registered insecticide in early to mid-July to control the adults. To determine spray date, start examining spittlemasses in early July, and spray when 95 percent of them are empty. (See Pesticide Table.) Control for Diplodia shoot blight if needed.
- Wash off the black discoloration caused by sooty mold by spraying the affected tree parts with a solution of 4 oz liquid detergent mixed in 100 gal of water. Apply under high pressure, preferably in late afternoon. Leave overnight and rinse tree with water the next morning.

#### NEXT CROP

- Plant the right species on the right site to avoid putting stress on trees. Stressed trees are more susceptible to spittlebug and shoot blight injury.



Pine spittlebug nymph inside spittlemass.



Pine spittlebug adult.



## Pine Tortoise Scale

**Hosts:** Scotch, Austrian, and red pine.

**Importance:** This scale extracts fluids from the shoots and branches of Christmas trees, thus stunting growth. Heavy attacks may kill trees or leave them unfit for Christmas tree sale by discoloring the needles and killing the branches.

**Look For:**

- *Discolored needles and dying shoots or branches*, particularly on the lower branches. Needles may look sooty and glisten as if lacquered. Many bees and/or ants may be on the needles, and some trees may be dead.
- *Reddish-brown, mottled, helmet-shaped scales*, up to ¼ in. in diameter, on the bark of injured shoots.

**Biology:** Young females overwinter on the bark of shoots and branches and produce hundreds of eggs in the spring. In June or July, tiny crawlers (nymphs) hatch and crawl out from under the scales. Ladybugs frequently feed on the

crawlers at this time, and can usually control light infestations before trees are injured. The female crawlers attach themselves permanently to the tree and develop into soft scales. While feeding, they secrete a shiny, sugary waste product called honeydew, which coats the nearby branches and eventually turns black. Bees and ants feed on this honeydew.

**Monitoring:** Examine trees of all ages from May to June, looking for "sooty" needles. Treat individual, infested trees and seedlings if scales are obvious, or if trees are ready for harvest.

**Control:**

**THIS CROP**

- Cut and burn heavily infested trees before mid-June to reduce spread of crawlers.
- Coat trees completely with "dormant" or "superior" oil before buds break to kill immature scales.

- Or, drench each infested tree once with a registered insecticide between mid-June and mid-July to kill emerging crawlers. Use a hand lens to check for pinkish eggs or small, crawling insects on the undersides of scales in mid-June. The best time to spray is when almost half of these crawlers have emerged. If timing is incorrect, a second drenching may be needed. (See Pesticide Table.)

- Wash off the black discoloration caused by sooty mold by spraying affected tree parts with a solution of 4 oz liquid detergent mixed in 100 gal of water. Apply under high pressure, preferably in late afternoon. Leave overnight and rinse with water the next morning.

- Do not ship infested trees because scales "hitchhike" to new areas this way.

**NEXT CROP**

- Plant only pest-free stock.
- Do not plant susceptible pines next to a scale-infested stand or windbreak without first treating to control scales.



*Dying shoots and branches.*

*Inset: Pine tortoise scale on sooty bark.*

Photo by Gary A. Simmons, Michigan State University.



## Saratoga Spittlebug

**Hosts:** Scotch and red pine; occasionally eastern white pine and balsam fir.

**Alternate Hosts:** Sweetfern; brambles (raspberry and blackberry); broad-leaved weeds.

**Importance:** Spittlebug adults feed on and discolor foliage, stunt branches, and leave trees unfit for Christmas tree sale. Heavy feeding for 2 or 3 years can kill Scotch and red pine Christmas trees.

### Look For:

- *Reddish or reddish-brown (flagged) branches*, particularly in the upper part of the tree. Severely injured trees brownup and die.

- *Tan or brownish flecks on the wood* under the bark of older portions of branches. Scrape bark away with a knife to see the flecks.

- *Dense ground cover with many alternate hosts.*

MID-MAY—EARLY JULY

- *Frothy masses of spittlelike bubbles at the base of sweetfern or brambles.*

- *Small, red and black or chestnut-brown insects* in these spittlemasses.

LATE JUNE—SEPTEMBER

- *Tan and white, boat-shaped insects*, 1/8 in. long, on the tree. Each has a white, arrow-shaped marking on its front end. Spittlebug adults will jump away when disturbed.

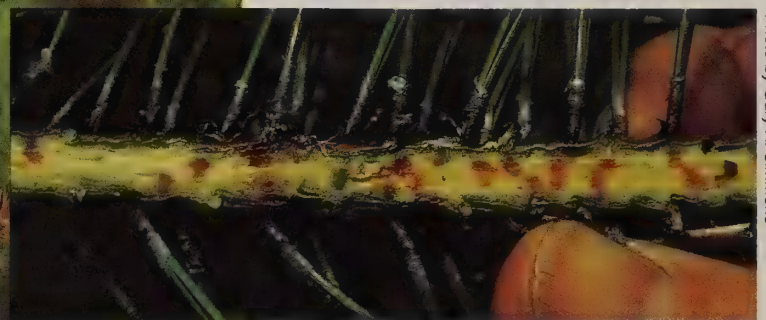
Pests that cause similar symptoms: Diplodia shoot blight, p. 54; meadow spittlebug (green insects in spittlemasses in the tops of weeds and grasses, not a Christmas tree pest), p. 58; northern pine weevil, p. 59; pales weevil, p. 61; pine root tip weevil, p. 62; pine spittlebug, p. 62; scleroderris canker on pine, p. 65.

**Biology:** Nymphs hatch in spring and drop from trees to feed on alternate host plants. They cover themselves with the characteristic spittlemass made of fluids from the host plants. In late June or early July, adults return to the trees to suck sap from the shoots and lay eggs. This feeding scars the inner bark and wood and blocks vessels that carry water and nutrients to the rest of the tree.

**Monitoring:** Examine sites before planting and check between rows of young trees after planting. Look for and treat pockets of sweetfern, blackberry, and raspberry if they occupy more than 20 percent of the open ground cover. Randomly select five Christmas trees scattered throughout the plantation. Scrape the bark off the 2-year-old shoot portion of any branch in the upper half of each tree, and look for flecks (feeding scars) on the wood. Consider treating adult spittlebugs if there are more than 20 flecks per 4 in. of branch length.



Flagged branches.



Inset: Tan or brownish flecks on wood beneath bark.



Inset: Saratoga spittlebug adult.

Photo by Gary A. Simmons



## Scleroderris Canker

### Control:

#### THIS CROP

- Use a herbicide to limit nongrassy vegetation to less than 20 percent of the ground cover within 20 ft of the trees. Without these nongrassy, alternate hosts, spittlebugs cannot complete their life cycle. (See "Weeds, broad-leaved" in Pesticide Table.)
- Apply a registered insecticide to the trees in early to mid-July to kill emerging adults before they lay eggs. The best time to treat trees is when 90 percent of the spittlemasses on sweetfern or brambles are empty. (See Pesticide Table.)

#### NEXT CROP

- Use a herbicide to destroy nongrassy vegetation before planting trees and limit it throughout the growing cycle to less than 20 percent of the ground cover. (See "Weeds, broad-leaved" in Pesticide Table.)



Dense ground cover of sweetfern--an alternate host.



Frothy spittlemass on sweetfern.

**Hosts:** All pines; occasionally spruces, firs, and Douglas-fir.

**Importance:** The European strain of this disease attacks and kills trees of all ages, causing heavy losses in plantations. The North American strain only kills trees less than 6 ft tall and can seriously damage Christmas trees during the first 5 years after planting.

### Look For:

- *Cankers--oblong, sunken areas* on the stem and branches, commonly inconspicuous. Remove the bark and look for a slight swelling on the wood surface.
- *Green discoloration beneath the bark* of dead branches.

#### MAY-JUNE

- *Orange discoloration at the bases of needles*, usually on the lower 3 ft of the tree. These needles fall off easily.
- *Dead buds on shoots* that have discolored needles.

#### JULY-NOVEMBER

- *Brown needles and branch tips*. Needles fall off when touched.

#### DECEMBER-APRIL

- *Dead branch tips with no needles*.

Pests that cause similar symptoms: Diplodia shoot blight and canker, p. 54; drought, p. 26; pine root tip weevil, p. 61; pine spittlebug, p. 62; Saratoga spittlebug on pine, p. 64.

**Biology:** Branch tips usually become infected in May and June, but infection sometimes takes place from February through November. Spores are wind-blown or rain-splashed from infected nursery stock and infected, cut Christmas trees.

**Monitoring:** Examine trees of all ages in May or June when orange needle discoloration is most obvious. Check the lower branches of trees in low spots in the plantation, and remove infected branches immediately. Continue to check branches each year, especially if scleroderris canker is present in natural stands within ¼ mile of your plantation.

### Control:

#### THIS CROP

- Remove all infected branches.
- Do not shear infected foliage during wet weather because spores released at this time can be carried from tree to tree on shearing tools. Sterilize tools after shearing infected stands by dipping in denatured alcohol for 3 minutes.
- Shear healthy plantations first so spores will not be carried from infected plantations to healthy ones. Note: Chemical controls are available to protect nursery stock, but may be too expensive for plantation use. (See Pesticide Table.)

#### NEXT CROP

- Plant only pest-free nursery stock.
- Plant resistant species such as spruce or fir in areas where scleroderris canker is present.



Green discoloration on dead branches.



Orange discoloration at the bases of needles.



## Spruce Bud Scale

**Hosts:** All spruces.

**Importance:** This scale sucks fluids from the shoots and branches of Christmas trees, but usually does not damage trees. Heavy attacks, however, may kill a few trees or stunt new shoots, leaving trees unfit for sale.

**Look For:**

- *Discolored needles and dying shoots, particularly on the lower branches.*
- *Dusty, red-brown, globelike scales, up to 3/16 in. in diameter, that look like abnormal buds at the bases of current shoots.*

**Biology:** Young females overwinter on the bark of shoots and branches and produce hundreds of eggs in the spring. In June or July, tiny crawlers (nymphs) hatch and crawl out from under the scales. Ladybugs frequently feed on the crawlers at this time. The female crawlers attach themselves permanently to the tree and develop into soft scales.

**Monitoring:** Examine trees the year before harvest. Ladybugs will usually control light infestations. However, if predators are not effective or if you notice scales on trees that are ready for harvest, treat entire plantation.

**Control:**

**THIS CROP**

- Cut and burn heavily infested trees before mid-June to reduce spread of crawlers.
- Coat trees completely with dormant oil before buds break to kill immature scales.
- Or, drench trees once with a registered insecticide between mid-June and mid-July to kill emerging crawlers. Use a hand lens to check for pinkish eggs or small, crawling insects on the undersides of scales in mid-June. The best time to spray is when almost half of these crawlers have emerged. If timing is incorrect, a second drench may be needed. (See Pesticide Table.)
- Do not ship infested trees because overwintering scales "hitchhike" to new areas this way.

**NEXT CROP**

- Plant only pest-free nursery stock.

## White Pine Blister Rust

**Host:** White pine.

**Alternate Hosts:** Gooseberry, currant.

**Importance:** White pine blister rust produces cankers that kill branches and lower the market value of Christmas trees. Cankers on the trunk can girdle and kill trees.

**Look For:** (On pine)

- *Patches of brown bark with yellow borders.* This signals the first year of infection.
- *Spindle-shaped swellings* that appear on the branches or trunk during the second year of infection.
- *Signs of resin flow and rodent feeding* on mature, yellow-bordered cankers.
- *Reddish-brown needles* on dead branches and tree tops above trunk cankers.

**MAY**

- *Cream-colored blisters* pushing through the diseased bark. These break open and release orange-yellow spores.

**JUNE-JULY**

- *Yellow-brown blisters* on the canker that produce a sticky, orange fluid that later hardens and turns black.

**Look For:** (On gooseberry and currant)

**JUNE-AUGUST**

- *Orange spores* on the undersides of leaves.

**AUGUST-OCTOBER**

- *Brown, hairlike fungal growths* on the undersides of leaves.

Pests that cause similar symptoms: Pales weevil, p. 59; white pine weevil, p. 68.

**Biology:** This fungus needs both pine and an alternate host to complete its life cycle. It spreads from pine to gooseberry or currant, but cannot spread from pine to pine. The disease is usually most severe in regions where weather is cool and moist in August and September. Thus, the farther north, the greater the blister rust hazard.



The spruce bud scale looks like a bud.

Photo by Gary A. Simmons, Michigan State University.





*Reddish-brown needles above white pine blister rust canker.*

*Left inset: Patch of brown bark with a yellow border.*

*Right inset: Blisters pushing through diseased bark.*

**Monitoring:** Inspect 5- to 10-year-old trees in May. Randomly select 50 or more trees scattered throughout the plantation, and look for branch flagging and orange blisters on branches or trunks in May. If more than 10 percent of these trees are infected, remove cankers and control alternate hosts before August.

### Control

#### THIS CROP

- When shearing Christmas trees, prune off all brown branches that have cankers. This prevents the fungus from entering the trunk and killing the tree.
- Destroy and remove trees with trunk cankers.
- Remove or kill alternate hosts with a registered herbicide. (See "Weeds, broad-leaved" in Pesticide Table.)

#### NEXT CROP

- Avoid planting white pine where alternate hosts are abundant, especially in high-hazard, northern areas. If you do plant in these areas, plant resistant white pine or remove alternate hosts to reduce the likelihood of infection.
- For best results, plant white pine in low-hazard, southern zones where trees are less likely to be killed by white pine blister rust.



*Brown, hairlike growths on underside of leaf.*



## White Pine Weevil

**Hosts:** All pines; most spruces; occasionally firs.

**Importance:** The larvae of this common pest deform and degrade Christmas trees by killing the upper stem and top-whorl branches. A high percentage of trees may be injured 2 to 3 years after planting. This delays harvest for 1 or 2 years until those trees recover enough to be suitable for sale.

### Look For:

- **Dead or dying terminal leader** (topmost shoot on the mainstem), curled into the shape of a shepherd's crook. Lateral (side) branches on the first whorl may also die.

### MARCH-APRIL

- **Pitch flow on leader** where adult weevil is feeding or laying eggs.

### JUNE-AUGUST

- **Slightly curved, white larvae**, up to ¼ in. long, under the bark or in the wood of the damaged terminal.

- **Clumps of fine, white slivers of wood under the bark** in late summer. These woody chip cocoons may contain white pupae or brownish weevils, ¼ in. long.

### AUGUST-SEPTEMBER AND MARCH-MAY

- **Brown weevils** feeding on living terminals.

Pests that cause similar symptoms:  
Frost injury on tree top, p. 59; white pine blister rust, p. 66.

**Biology:** On warm, spring days, overwintering adults move from the litter to the tree tops to mate and lay eggs in the bark of the terminal leader. The larvae soon hatch and bore downward, eventually girdling the top of the stem and one or two whorls of branches. Larvae pupate in woody chip cocoons and emerge as adults from late July to late August. They feed on the bark of terminals before dropping to the litter to overwinter.

**Monitoring:** Begin checking for injury in June and concentrate on trees that will be harvested in 3 or 4 years. Treat entire plantation when injury becomes too severe to correct with pruning.

### Control:

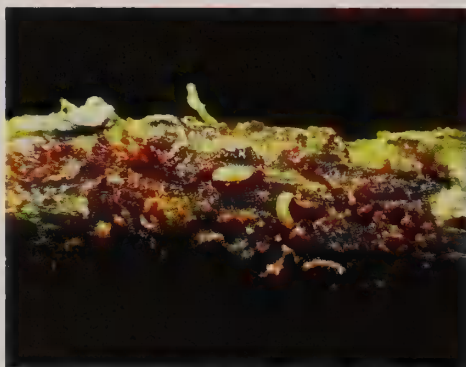
#### THIS CROP

- Prune and burn infested leaders before mid-July to kill the insects. Cut back all but one live, lateral (side) shoot by at least half their length to maintain single-stem dominance.

- Drench tree tops with a registered insecticide as weather warms to control egg-laying weevils. Eggs are usually laid in May in the Lake States and April in the Central States. A second treatment between mid-August and late September may be needed to control newly emerged adults. (See Pesticide Table.)

#### NEXT CROP

- Avoid planting highly susceptible white pine and Norway and Colorado blue spruce. If you do plant these species, isolate them from less susceptible pines and spruces.
- Plant resistant varieties of Scotch pines such as the Swedish variety. (See table on p. 11 for resistance rankings of Scotch pine.)
- If practical, remove old stands of eastern white pine or jack pine in and around plantation before planting.



White pine weevil larvae under bark.



Dead terminal curled into a "shepherd's crook."



White pine weevil adult with chip cocoon.



## Shoot/Branch Galls

Irregular or globelike swellings on shoot, branch, or mainstem. You may also find small pitch blisters in branch crotches that look like galls.









## Cedar-Apple Rust

**Host:** Eastern redcedar.

**Alternate Host:** Apple trees.

**Importance:** This rust kills branch tips and causes unsightly galls (globelike swellings) to form. When numerous, galls may slow growth and kill seedlings.

**Look For:**

- *Brown, warty galls*, ½ to 2 inches in diameter, on twigs of redcedar.

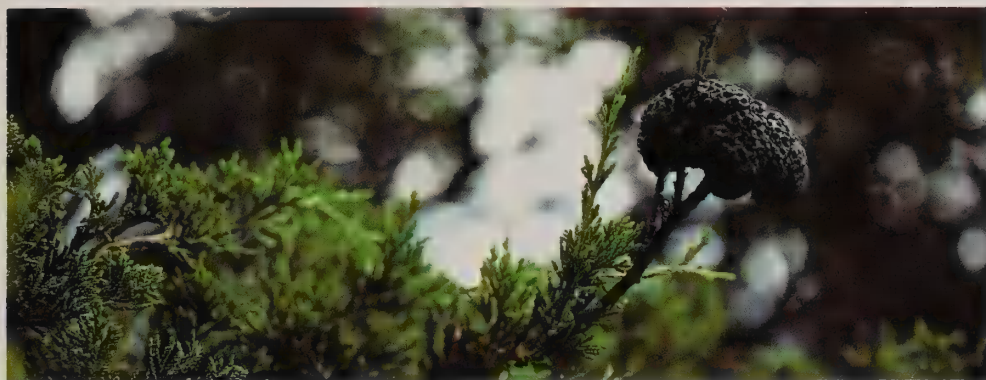
MAY-JUNE

- *Yellow-orange, jellylike fingers growing from galls*, especially during rainy weather.

JULY-SEPTEMBER

- *Orange leaf spots on nearby apple trees*.

**Biology:** After warm spring rains, cedar-apple rust spores are produced in the yellow-orange fingers that erupt from round, woody galls on redcedar twigs. These spores spread to nearby apple trees where they cause orange spots on leaves and fruits. In summer and early fall, another type of spore produced on the apple trees infects nearby redcedar and causes new galls to form.



*Brown, warty gall.*



*Jellylike fingers growing from galls.*

**Monitoring:** In spring, look for galls on redcedar of all ages. If galls are too numerous to hand-clip and are killing seedlings or making older trees unsalable, consider treating galls with fungicides.

**Control:**

THIS CROP

- Clip off galls on redcedar.
- If practical, remove nearby apple trees to reduce infection on redcedar.
- Apply a registered fungicide to the orange, jellylike galls once during the spring, and/or spray redcedar foliage three times, once every 2 weeks, beginning in mid-summer. (See Pesticide Table.)

NEXT CROP

- Avoid planting redcedar near apple trees.

## Cooley Spruce Gall Aphid

**Hosts:** Colorado blue spruce; Douglas-fir.

**Importance:** The nymphs of this species cause long, curved, persistent galls to form on the new shoot tips of blue spruce. These attacks often kill shoots, deform the tree, and lower its value as a Christmas tree. On Douglas-fir, nymph feeding discolors and distorts needles, but does not produce galls.

**Look For:** (On spruce)

- *Galls--conelike, green, purple, or brown swellings*, 2 to 2½ in. long, on the tips of new shoots.

**Look For:** (On Douglas-fir)

- *Yellow spots on bent needles*, caused by nymph feeding.
- *Small, cottony balls* dotting the undersides of needles.

**Biology:** On spruce, young females lay eggs in the spring under a mass of white, cottony wax near the terminal (end) bud. Nymphs hatch and feed at the needle bases of expanding buds, producing galls that enclose and protect them. After galls dry up in mid-summer, the exposed nymphs will either continue their life cycles on blue spruce or fly to Douglas-fir to lay eggs. Feeding on Douglas-fir does not cause galls to form. The nymphs overwinter, and the next spring the winged forms fly back to spruce, where they reproduce gall-forming aphids and thus complete the life cycle. These aphids can complete their life cycle on 1 or 2 hosts; however, injury tends to be more serious when they move between two hosts.



*Green and brown galls on spruce shoot tips.*



## Eastern Spruce Gall Aphid



Yellow spots on Douglas-fir needles are caused by cooley spruce gall aphid feeding.



Cottony balls dotting Douglas-fir needles.

### Monitoring:

On spruce: Look for brown galls on trees of all ages in August. If galls are few and scattered, remove by hand. If galls are too numerous to hand clip, treat entire plantation this fall or next spring.

On Douglas-fir: Monitor trees of all ages throughout the growing season. If you find small, cottony balls on the undersides of needles, treat entire nursery or plantation.

### Control:

THIS CROP: (On spruce)

- Clip off and destroy scattered galls before they open in July.
- Cut and destroy heavily injured trees.
- If needed, spray trees with a registered insecticide just before spruce buds break in late April or early May. (See Pesticide Table.)

■ Or, apply a dormant oil in early spring or late fall when trees are dormant. (See Pesticide Table.)

THIS CROP: (On Douglas-fir)

■ To control overwintering aphids, apply registered insecticide to trees in October or just before Douglas-fir buds break in April or early May. Spray trees when the temperature is above 60° F.

■ Or, apply dormant oil in early spring or late fall when the trees are dormant. (See Pesticide Table.)

NEXT CROP

- Keep Colorado blue spruce and Douglas-fir apart to limit the problem.
- Plant resistant varieties of Douglas-fir if available.

**Hosts:** Norway, red, white, Black Hills, and black spruce.

**Importance:** The nymphs of this species cause swellings or galls to form at the bases of young shoots. The galled shoots become brown, stunted, and deformed, making the tree unfit for sale. A single tree may have hundreds of galls and be repeatedly attacked.

### Look For:

■ *Pineapple-shaped, green or brown galls*,  $\frac{3}{4}$  to 1 in. long, at the bases of new shoots.

**Biology:** Females overwinter near end buds and lay eggs at bud bases in spring when buds begin to break. Nymphs hatch and feed in clusters on new needles, which collectively swell into the characteristic gall. The gall opens between mid-August and October, allowing the adults to emerge, disperse, and reproduce.

**Monitoring:** Look for brown galls on trees of all ages in mid- to late summer. If galls are too numerous to hand-clip, treat infested trees this fall or next spring.

### Control:

THIS CROP

- Clip off and destroy scattered galls before they open in late July.
- Cut and destroy heavily injured trees.
- Spray infested trees with a registered insecticide in early April just before the buds begin to swell, or mid- to late September after galls have opened. (See Pesticide Table.)
- Keep trees vigorous to avoid infestation.

NEXT CROP

- Plant more resistant forms of spruce.



Pineapple-shaped, green galls.



## Gall Rusts

**Hosts:** Scotch, jack, and ponderosa pine.

**Alternate Hosts:** Oak, sweetfern, cowwheat, false toadflax, and others.

**Importance:** Rust infections on stems slow growth and gradually kill older trees. Young seedlings are girdled and killed quickly. Rust infections on branches kill individual branches, but not trees.

### Look For:

- *Stem cankers*--rough, sunken areas of the trunk, usually at the base of the tree.
- *Heavy resin flow from stem cankers.*
- *Galls*--globelike or spindle-shaped swellings on trunk or branches.
- *Red needles* on recently killed branches.

APRIL-JUNE

- *Cream-colored blisters filled with orange spores*, located on the surface of galls.

**Biology:** Windborne spores of pine-pine (western) gall rust spread directly from pine to pine. Other types of gall rust fungi must complete part of their life cycle on an alternate host, such as sweetfern, oak, cowwheat, or false toadflax before they can reinfect pine.

**Monitoring:** Randomly select at least 50 trees scattered throughout the plantation, and look for branch and stem galls at anytime during the year. If young trees up to 7 years old average more than three galls per tree, consider treating entire stand. Treat alternate hosts found within ¼ mile of plantation. If no alternate hosts are present, prune galls to prevent the spread of pine-pine gall rust.



Globelike gall.

### Control:

#### THIS CROP

- Destroy and remove alternate hosts from plantations so that two-host rust fungi cannot complete their life cycle.
- Control pine-pine gall rust by removing galls from trees before they produce spores that can infect other pines.

- Control rusts in nurseries by applying a registered, preventive fungicide. Have a pest specialist identify the rust and prescribe the best treatment and timing for your area. (See Pesticide Table.)

#### NEXT CROP

- Before planting, inspect stock for swelling caused by rust infection.
- Replant failed plantations with a non-host species.



Swelling on seedlings.



This stem gall is a telltale mark of a gall rust infection.



## Northern Pitch Twig Moth (Pitch Nodule Maker)

**Host:** Scotch pine.

**Importance:** The larvae of this moth remove small amounts of bark in the crotches of young branches. This kills or deforms a few branch or stem tips, but seldom degrades Christmas trees. This pest usually occurs only within the range of jack pine, its preferred host.

**Look For:**

- A hollow, thin-walled, brownish pitch blister (nodule), about  $\frac{1}{2}$  to  $\frac{3}{4}$  in. in diameter, in a branch crotch. Branch may be flagged (discolored and deformed) beyond the blister.
- Small, reddish-brown larvae,  $\frac{1}{2}$  in. long, inside the blister.

**Biology:** This insect needs about two seasons to complete a full life cycle. The young larva constructs a small, blister-like nodule on a growing tip and overwinters there. The next spring, the larva moves to a twig notch and forms a larger nodule—the one normally seen on the tree. After pupating, the moth emerges and repeats the cycle.

**Monitoring:** Begin looking for pitch blisters when trees reach shearing age. Treat by hand if common.

**Control:**

THIS CROP

- Ignore the problem, or break open pitch blisters and crush the larvae.
- Clip off flagged, broken, or crooked branches and leaders while shearing, or simply wait for broken branch tips to fall off.



*Pitch blister built by northern pitch twig moth larva.*



## Dead Tree and Stem/Root Injury

Whole or most of tree dead or dying—turning yellow, red, or brown. Needles may fall off in later stages. Some trees may be leaning or fallen over. Evidences of stem injury include masses of pitch, holes in bark, and girdling (bark removal). Your tree may be in the advanced stages of injury caused by other pests; so, if you can not find the agent here, check pests in other injury categories.









## Allegheny Mound Ant

**Hosts:** All Christmas tree species.

**Importance:** Mound ants kill all vegetation within 20 ft of their mounds (nests), including seedling or sapling conifers. The ants will also kill large trees that are as far away as 50 ft if those trees shade their mounds.

**Look For:**

- **A group of dead or dying trees.** Search the bases of affected stems for symptoms of injury, such as small, blisterlike swellings.
- **A large ant mound,** 1 to 3 ft high and 2 to 6 ft across, located among the injured trees.
- **Large ants,** ¼ in. long, with either black or reddish-brown front ends and red tail ends. Look for ants on the mound or on live trees.

Pests that cause similar symptoms:  
Pocket gopher, p. 81.

**Biology:** These ants kill trees that shade their mounds by injecting formic acid into the bark of the lower trunk. The ants also protect aphids and scales on live trees by discouraging the aphids' natural enemies (parasites and predators).



Large Allegheny ant mound.

**Monitoring:** Look for mounds between trees or rows of trees in stands of all ages throughout the growing season. Treat individual mounds as soon as you find them.

**Control:**

THIS CROP

- Kill adult ants by applying a registered, residual insecticide to mounds any time between mid-April and October. Either level the mound with a rake before treating, or mix the chemical into the upper 2 to 3 in. of the mound. For best results, apply just before a heavy rain. Treat again if a new mound appears. Be careful; these ants tend to be vicious and will bite. (See Pesticide Table.)
- Keep aphid and scale populations low.

NEXT CROP

- Level and treat mounds before planting a new crop of trees.

## Armillaria Root Rot (Shoestring Root Rot)

**Host:** All trees.

**Importance:** This fungus kills by girdling trees at the root collar. Trees under stress and trees in cutover hardwood stands are most susceptible to infection.

**Look For:**

- **Yellowing, then browning of all needles.**
- **Resin on the bark at the root collar,** where the stem and roots meet.
- **Creamy white, leathery sheets of fungus** under the bark at the root collar.

Pests that cause similar symptoms:  
Drought, p. 26; pine root collar weevil, p. 79; wood borers and bark beetles, p. 82.

**Biology:** Black, fungal strands (rhizomorphs or "shoestrings") from diseased stumps grow through the soil and infect nearby conifers.

**Monitoring:** Not necessary.

**Control:**

THIS CROP

- Remove dead trees, infected stumps, and large roots.
- Reduce stress by treating for other diseases, insects, and environmental factors that damage or weaken trees. Healthy, vigorous trees are more resistant to Armillaria infection than diseased, weak ones.

NEXT CROP

- Choose a site that is well suited to the growth needs of the desired species. Avoid planting on cutover sites, especially those with many large, hardwood stumps.
- If practical, remove stumps and large roots before planting.
- Maintain healthy, vigorous trees.



White sheets of fungus under bark at root collar.



## Mouse

**Hosts:** Most Christmas tree species.

**Importance:** Meadow voles, commonly called meadow mice, feed on bark around the base of the trunk or on lower branches, weakening trees, slowing growth, and discoloring needles. Mice may kill trees by removing a complete ring of bark from the trunk (girdling).

### Look For:

- *Active mouse runways*, 2 in. wide, devoid of live vegetation. Look for runways in areas of heavy vegetation.
- *Piles of droppings and small caches of clipped grass.*

### MARCH-APRIL

- *Girdling of the trunk near the soil line*, especially on trees in heavy grass.

### MAY-JULY

- *Lack of new, developing shoots.*
- *Completely brown trees* killed by girdling.

Pests that cause similar symptoms: Rabbit and hare, p. 81.

**Biology:** The meadow mouse, commonly found in grassy fields, feeds mainly on grasses and other succulent vegetation throughout the growing season. During the winter, when mouse populations are high and normal food supplies dwindle, mice turn to eating tree bark. Feeding generally occurs below the snow line in areas of dense, matted vegetation, so injury may not be discovered until the snow melts.

**Monitoring:** Look for dead trees and injury in stands of all ages throughout the growing season. If you see mice and their runways frequently in the fall during harvest, use poison baits to protect trees. If you control weeds regularly, monitoring may not be necessary.

### Control:

#### THIS CROP

- Prune off girdled branches. Nothing can be done to save trees with girdled trunks.
- Mow close to the ground in late fall to destroy mouse habitat.
- Or, apply a registered herbicide to eliminate winter cover. (See "Weeds" in Pesticide Table.)
- If needed, place registered poison baits in covered bait stations so songbirds or other wildlife cannot reach them. Because high mouse populations occur in cycles, poisoning is not needed every year. (See Pesticide Table.)
- Or, spray repellent mixed with adhesive on the base of the trunk. One application should last all winter. (See Pesticide Table.)

#### NEXT CROP

- Remove grassy vegetation on or around site before planting and continue to control vegetation throughout the life of the trees in areas where mice may be a problem.



Active mouse runways.



Inset: Adult mouse.



Mice girdled this trunk near the soil line.



## Pine Bark Aphid

**Hosts:** Eastern white pine; occasionally Scotch and Austrian pine.

**Importance:** Pine bark aphids weaken pine trees by sucking the sap. Heavily infested trees grow poorly, become discolored, and lose their value. Some trees may die or become weak and susceptible to other pests during dry periods.

### Look For:

- *Discolored, stunted, weakened, or dying trees* with small but conspicuous lumps of white, woolly wax on the main stem and large branches. The trunk may look whitewashed.
- *Yellow or purplish insects*, less than 1/25 in. long, under the woolly wax. Use a hand lens.

MAY-JUNE

- *Dark, blue-green nymphs covered with white, waxy material*, found in clusters on elongating shoots.

**Biology:** Mature females covered with woolly wax overwinter on the tree. Eggs laid in the spring produce wingless and winged forms that infest new hosts.

**Monitoring:** Inspect trees of all ages throughout the growing season. Look for white, woolly wax and blue-green nymphs early in the growing season. Treat entire plantation if you notice this aphid in any stage.

### Control

#### THIS CROP

- Spray trees with a dormant oil before growth starts in the spring. Do not spray until the temperature stays above 40° F for 24 hours. Inspect the woolly wax in early May with a hand lens to make sure the insects underneath are dead.
- Or, drench trees with a registered insecticide in mid-May, when the insects are active. (See Pesticide Table.)

#### NEXT CROP

- Avoid planting eastern white pine, especially near Scotch and Austrian pine.



David J. Sheltar, Pennsylvania State University

Aphids under woolly wax on trunk.

## Pine Root Collar Weevil

**Hosts:** Scotch, Austrian, and red pine; occasionally white pine.

**Importance:** The larvae of this weevil girdle the root collar (where the stem and roots meet) and roots of young pine Christmas trees larger than 1/2 in. in diameter at the soil line. Complete girdling kills trees. Trees weakened by weevils may fall over and die 1 to 4 years after being attacked.

### Look For:

- *Yellow to red needles on entire tree.* Some trees, including some with green foliage, may be leaning or fallen.
- *Black, pitch-coated bark at the root collar* and beneath the soil. Soil around tree may also be pitch-soaked.
- *Yellow-white, legless, C-shaped larvae*, up to 1/3 in. long, with amber-brown heads. Look for them in tunnels in the bark or in adjacent soil.

LATE JUNE-EARLY SEPTEMBER

- *White pupae*, up to 1/3 in. long, in the bark and soil where larvae are found.

Pests that cause similar symptoms: Armillaria root rot, p. 77; wood borers and bark beetles, p. 82. Pales weevil adults, p. 59, and pine root tip weevil adults, p. 61, are nearly identical to pine root collar weevil in appearance.

**Biology:** In the spring and summer, adult weevils lay eggs at the bases of pines during the day and move onto the trees at night to feed. Weevils normally move only short distances, but will occasionally fly to other locations. The larvae feed on the inner bark of the root collar and pupate in the nearby soil. Adults emerging in late summer feed on the trees for a short time before entering the litter to overwinter. Most will live for more than 1 year.



David J. Sheltar, Pennsylvania State University

Pine root collar weevil adult.



**Monitoring:** Begin inspecting when trees reach 1 in. in diameter at the base. If some trees are dying, treat all trees except healthy-looking ones that are ready for immediate harvest. If trees are not dying, look for injury at bases of 20 to 30 scattered trees sometime before mid-May and again before mid-August. Treat entire plantation if 50 percent of the inspected trees are injured. White pines need not be checked unless they are next to or intermixed with infested pines.

#### Control:

##### THIS CROP

- Prune off one to three whorls of branches growing within 1 ft of the ground before treating the tree.
- Drench a 1-ft radius of soil around each tree with a registered insecticide during warm weather to kill adults. The

best time to treat is in mid-May, before the adults lay eggs. Apply again in mid-August to control newly emerging weevils. (See Pesticide Table.)

##### NEXT CROP

- Delay replanting of harvested areas for 1 year to deprive weevils of newly planted seedlings. If you do replant immediately or interplant with seedlings, do not plant pines.
- Do not mix pine species. Separate different pine species in the same stand by at least 100 ft.
- Plant Scotch, Austrian, or red pine at least ½ mile away from weevil-infested pines.
- Plant resistant varieties of Scotch pine, particularly the short-needled varieties such as S. French, Turkish, or others from West or South Eurasia. (See table on p. 11 for resistance rankings of Scotch pine.)

## Pine Wood Nematode

**Hosts:** Pines, especially Scotch pine.

**Importance:** When present in large numbers, these microscopic worms can kill the pine saplings they infest. The number of trees killed by nematodes increases during periods of drought. Nematodes are often found in trees that are dying from other causes.

#### Look For:

- *Yellowing, then browning of all needles* during the growing season. Brown needles remain on dead trees.
- *A lack of resin flowing from wounds.*

Pests that cause similar symptoms: Wood borers and bark beetles, p. 82.

**Biology:** Pine wood nematodes are spread from dead to healthy or stressed pines in the spring by long-horned beetles. Nematodes reproduce rapidly in the wood of infested trees during the summer, usually killing trees by fall.

**Monitoring:** Not necessary.

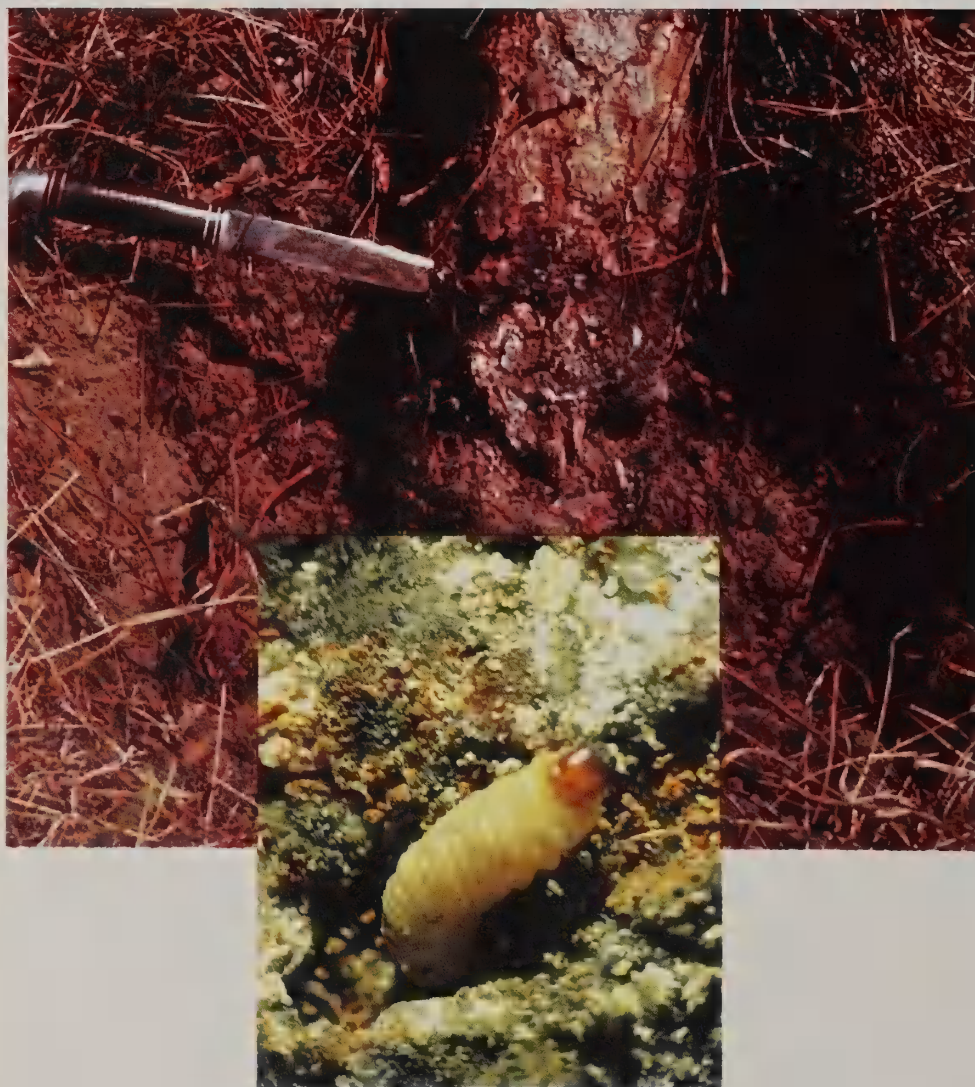
#### Control:

##### THIS CROP

- Have a pest specialist examine the wood of a recently killed tree to determine if nematodes are present.
- Destroy infested trees by burning or chipping before beetles emerge from them in the spring.

##### NEXT CROP

- Avoid planting on dry sites.



Pitch-coated bark at the root collar.  
Inset: Pine root collar weevil larva.



All needles turn yellow.



## Pocket Gopher

**Hosts:** Most Christmas tree species.

**Importance:** Pocket gophers weaken or kill trees by feeding on their roots.

**Look For:**

- *Ridges in the soil* caused by underground burrowing.
- *Semi-circular mounds of soil.*
- *Yellow to brown needles and dead trees* near mounds and ridges.
- *Destroyed tree roots.*

Pests that cause similar symptoms: Allegheny mound ant, p. 77.

**Biology:** The pocket gopher is a burrowing rodent 5 to 8 in. long, including a short, sparsely haired tail. These animals have small eyes and ears, short necks, chisel-like teeth, and long, strong claws on their feet. Coat color ranges among species from almost white, to brown, to black. Solitary for much of their lives, they are active day and night but are seldom seen above ground. Christmas tree plantations are a favorite feeding ground for gophers because the soil is usually easy to work.

**Monitoring:** Inspect trees of all ages in spring. Consider controlling gophers if mounds are numerous and more than 10 percent of your trees die because of injured roots.

**Control:**

**THIS CROP**

- For small-scale problems, trap and hand-bait pocket gophers. (See Pesticide Table.)
- For larger populations, use a burrow builder—a tractor-drawn device that digs underground runways and baits them with poison. Drive the machine back and forth at regularly spaced intervals (about 25 ft apart) to make a series of parallel burrows that will intercept the natural gopher burrow systems. Gophers will explore these artificial tunnels and eat the poisoned bait within.



*Tree roots chewed off by pocket gophers.*

## Rabbit and Hare

**Hosts:** All pines; occasionally spruce and fir.

**Importance:** Rabbits and hares feed on the bark and the lower branches of young pines. In large numbers, these animals can cause great damage to pine plantings. Severely injured trees may be girdled and killed or may be too damaged to be sold as Christmas trees.

**Look For:**

- *Dead or dying trees.*
- *Exposed wood* where stem and branches have been bark-stripped or girdled. Rabbits and hares will feed as high up on the stem and branches as they can reach by standing on their hind legs.
- *Tooth marks*, 1/10 in. wide, running horizontally across the stem.
- *Smooth, clean, slanted cuts* where rabbits have clipped off branches.
- *Rabbit or hare droppings and tracks* near trees.

Pests that cause similar symptoms: Deer, p. 53; mouse, p. 78.

**Biology:** Rabbits and hares may feed on tree bark during the winter if there is an overabundance of these animals and if their normal, preferred foods are scarce.

**Monitoring:** Look for damage on trees of all ages in the spring, especially in areas with heavy brush (good rabbit and hare habitat). No control is needed if injury is random and infrequent. If damage is serious, check with a conservation officer or a wildlife pest control specialist to see if control is appropriate under local conditions.

**Control:**

**THIS CROP**

- Discourage rabbits and hares by removing necessary cover such as brush piles and bushy field borders.
- When appropriate, use a rabbit or hare repellent for some degree of control. Control is difficult and often ineffective. (See Pesticide Table.)



*Semi-circular mounds of soil left by pocket gophers.*



## White Grubs

**Hosts:** All Christmas tree species.

**Importance:** The larvae of May beetles, called white grubs, feed on the roots of Christmas tree seedlings, killing many seedlings, and slowing the growth of the rest. Injury usually occurs during the first two growing seasons after planting, and is most severe on abandoned farmland that has recently been converted to Christmas tree plantings.

**Look For:**

- **Dead or dying seedlings** scattered throughout the stand or nursery.
- **Fibrous roots missing from dead seedlings.** Dig or gently pull up seedlings to see this.

**MAY-SEPTEMBER**

- **White, C-shaped larvae**, up to 1 in. long, with brownish heads and six brown legs. Dig in the upper 6 in. of soil to find them.

**Biology:** White grubs normally feed on grass roots, but turn to tree seedling roots when grass roots are scarce. In May or June, the adult beetles emerge from the soil and feed on broad-leaved hardwoods near the field. They return to the field to lay eggs in the soil. The hatched larvae burrow deeper in the soil and feed on roots for two to five growing seasons before becoming adults. Seedlings that are J-rooted because of careless planting are killed first.



*Fibrous roots chewed off by white grubs.*

**Monitoring:**

**Before Planting**—Check planting sites in July and August of the year before planting, except during long periods of drought. Run a furrow and look for grubs. If you find 1 grub per 10 linear feet, treat seedlings or site just before or during planting.

**After Planting**—Check monthly throughout growing season for 3 years after planting. Treat the entire plantation if you find any grub-killed seedlings.

**Control:**

**THIS CROP**

- Broadcast registered, granular insecticide over the field or spread a 2-ft-wide band of pesticide between each row of trees. Disk it in to a depth of 4 in. and as close to the seedlings as possible. (See Pesticide Table.)

**NEXT CROP**

- Apply registered, granular insecticide before planting as described above. Use broadcast and disk treatment for nursery beds.
- Or, dip seedling roots in a registered insecticide solution before planting. (See Pesticide Table.)
- Spread roots out in planting hole to prevent J-rooting.
- Use herbicides to control grasses before August in the year before planting. (See Pesticide Table.)



*White grub larva.*

## Wood Borers and Bark Beetles

**Hosts:** All Christmas tree species.

**Importance:** The larvae of wood borers and bark beetles attack and destroy the woody tissues—branches, stems, and roots—of weak, dying, or dead Christmas trees. A few species of bark beetles can kill very weak trees that might have survived if left unattacked.

**Look For:**

- **Dead or dying trees or parts of trees.**
- **Galleries (chambers) and tunnels under loose bark** that have been made by bark beetles or wood borers. They may contain white larvae, 1/16 in. to 1 in. long, or adult beetles. Listen for borers gnawing on the wood.

Pests that cause similar symptoms: Pine root collar weevil, p. 79; pine wood nematode, p. 80. Pales weevil, p. 59, carves galleries in the roots *below* wood borers and bark beetles.

**Biology:** Adult wood borers and bark beetles lay eggs in the bark of weak and dead Christmas trees. The larvae tunnel in and feed on the bark and woody tissues, often sharing the host with several different insect species. Bark beetles may eventually emerge from one tree and attack surrounding, weak trees.

**Monitoring:** Inspect trees of all ages during and after periods of drought, grass fire, and other disturbances. Look for pockets of dead trees and treat accordingly.

**Control:**

**THIS CROP**

- Remove and destroy dead or infested trees to get rid of the insects.
- Look for the primary source of the problem, i.e., what is weakening or killing trees *before* the borers or beetles infest them.
- Maintain vigorous trees; fertilize as needed.

**NEXT CROP**

- Do not replant on the site, especially if it is marginal, until you have identified and controlled the pest that is weakening the trees.



## Yellow-Bellied Sapsucker

**Hosts:** Scotch and Austrian pine; occasionally other conifers.

**Importance:** Sapsuckers peck holes in the bark of sapling Christmas trees, causing trees to "bleed" sap. Trees are often repeatedly attacked, and when heavily injured, they may die. The injury also permits insects and diseases to enter the tree.

**Look For:**

- *Evenly spaced rows of large pits or holes (1/4 in. or larger) on trunk of tree.*
- *Upper portion of tree dead or dying.*
- *Robin-size woodpecker with bands of red, black, and white on the head. The belly is yellow and the back is white and black.*

**Biology:** The sapsucker is a forest bird that feeds on tree sap, the inner bark of trees, and the insects that get caught in the sap flowing from wounds on the trunk. This bird is a common migrant, a fairly common summer resident, but rarely a winter resident.

**Monitoring:** Examine trees within 3 years of harvest. If you notice any damage that might degrade or kill trees, take action to discourage the birds.

**Control:**

**THIS CROP**

- Apply a 2 or 3 in. band of "tanglefoot" just below and above the newly made row of holes to discourage the birds. Repeat if they attack new trees. Keep in mind that control is difficult and may not be justified in most cases.

**NOTE:** The yellow-bellied sapsucker is protected by the Federal Migratory Bird Treaty Act.



*Yellow-bellied sapsucker on trunk.*



*Bark beetle galleries.  
Inset: Wood borer larva.*





## Zimmerman Pine Moth

**Hosts:** All pines, especially Scotch and Austrian.

**Importance:** The larvae of this insect kill terminal leaders (topmost shoots) and occasional lateral (side) shoots of pines. Dead shoots will only slightly degrade trees, but repeated mainstem attacks may break off the tops of Scotch and Austrian pines, leaving them unfit for sale.

### Look For:

- **Coagulated pitch mass** at a branch whorl on the mainstem or on shoots near the terminal leader. The mainstem may be swollen above the mass, or broken off if tree is heavily injured. On Scotch pine, the attack site may be on a gall caused by one of the gall rusts of pines.
- **Discolored or broken leader** (sometimes a lateral), directly above a mass of coagulated, white or pinkish pitch.

### LATE MAY TO AUGUST

- **Pinkish-green, dark-spotted larvae**, up to  $\frac{3}{4}$  in. long, located inside shoots or pitch masses. Brown pupae,  $\frac{3}{4}$  in. long, can be found in shoots from mid-July to late August.

**Biology:** Larvae overwinter in bark crevices. They are active from early April to early May and bore into the shoot, stem, or gall-rust gall. They form a characteristic pitch mass at the entrance to the tunnel where they feed and later pupate. Adults emerge between mid-July and mid-August and lay eggs on the bark. The hatched larvae spin and overwinter in silken cases.

**Monitoring:** Inspect plantations regularly throughout the growing season. On Scotch and Austrian pine, look for pitch masses on the main stem. On other pines, including Austrian, look for pitch masses on shoots near the terminal leader. Treat entire plantation in the spring if injury becomes too severe to control by hand methods.

### Control:

#### THIS CROP

- Cut out area with pitch mass on mainstem using a pocket knife or shearing tool.
- Hand prune and destroy occasional, injured shoots.
- When insect is abundant or repeatedly attacks the mainstem, apply registered insecticide between early April and early May as the weather warms. Emerging larvae are most vulnerable to pesticides at this time, just before they penetrate the tree. Use enough nozzle pressure to drench stem and branch bark. (See Pesticide Table.)
- Do not ship infested trees because overwintering larvae "hitchhike" to new areas this way.

#### NEXT CROP

- Plant resistant varieties of Scotch pine, particularly the short-needled varieties such as Greece, Turkey, or others from West and South Eurasia. (See table on p. 11 for resistance rankings of Scotch pine.)



*Pitch mass below injured leader.*



## Where To Get Help

Because so many pests cause look-alike symptoms, it is sometimes difficult to pinpoint the pest causing damage in your nursery or plantation. When in doubt, contact a professional. Your State forester, county extension agent, or the staff at the plant disease and entomology clinics at your State university are familiar with local insects and diseases and can suggest practical, cost-effective controls. Christmas tree consultants are also available and can provide many of these services.

Some of the best advice may come from other growers who have dealt with a pest problem similar to yours. Joining a Christmas tree growers' association is a good way to connect and compare notes with growers in your area.

## How To Submit Material for Identification

In order to zero in on the culprit damaging or killing your trees, your local pest specialist will have to gather clues and examine the evidence. You can help by providing some background information:

- Location of plantation
- Site conditions (wet, dry, etc.)
- Age and species of affected trees
- Part(s) of tree damaged
- Pattern of damaged trees in plantations (scattered or grouped)
- Extent of damage (number of trees or acres affected)
- Management history (fertilization, pesticide and herbicide use, etc.)

In addition to these clues, you may need to send damaged plant tissue— foliage, branches, stems, or roots—as evidence of insect or disease activity. Include any tissue that contains fungal fruiting bodies, such as spore-filled "blisters."

These are telltale signs of disease.

Look on or around trees for physical evidence of insect activity, such as egg masses, pellets of waste, nests, or the insects themselves. If you spot insects feeding on your trees, send both the damaged plant tissue and the insects.

To insure correct identification, ship several examples of each type of injury, and follow these packing tips:

### Packing Plant Tissue:

- Fresh plant samples are easier to identify than dry, wilted ones, so

keep samples as cool as possible before mailing.

- **Foliage**—Pack green foliage samples in a plastic bag to keep them from drying out. Put dry paper towels in with the specimen to absorb water that might condense on the inside of the bag.
- **Branches and stems**—Cut samples at least 10 in. long and place in plastic bags with dry paper towels. Include apparently healthy portions of the same branch or stem section; often the junction of healthy and damaged foliage holds the key to identification.
- **Roots**—Pack roots in a plastic bag with some soil or litter, and keep them cool and moist.

### Packing Insects:

- DO NOT SHIP LIVE INSECTS.
- **Moths, butterflies, and beetles**—First kill with moth balls or crystals, then place them with egg masses, nests, or frass in jars or boxes. Loosely pack tissue paper above and below the specimens to protect them from damage.
- **Soft-bodied insects, egg masses, pupae, and larvae (caterpillars)**—Pack in vials filled with 70% alcohol (e.g., rubbing alcohol). Be sure to pad vials well enough to withstand rough handling in shipment.



When used correctly, pesticides can be an indispensable tool in Christmas tree culture. They are, in many cases, the fastest, most effective, and most economical way to control pests. When misused, however, pesticides can harm helpful organisms, the environment, and workers who handle the material. Overuse may also favor pests that are genetically resistant to pesticides. To minimize the hazards and get the most for your control dollar, make sure your field personnel are well versed in the basics of safe, effective pesticide use.

Chemical pesticides are usually "typed" according to their method of action and the kind of pest they control. Here are the types of pesticides commonly used in Christmas tree culture:

- Avicides—to control birds
- Fumigants—used in nurseries to control soil-borne fungi, nematodes, insects, and weeds
- Fungicides—to control fungi
- Herbicides—to suppress weeds
- Insecticides—to control insects
- Miticides—to control mites
- Repellents—to keep animal pests away, not kill them
- Rodenticides—to control mice, rats, and other rodents

Pesticide formulations commonly used are:

- A—Aerosols
- B—Baits
- D—Dusts
- E or EC—Emulsifiable concentrates
- L—Liquids
- G—Granules
- SP—Soluble powders
- W or WP—Wettable powders

The label on every pesticide container has vital information about that chemical's toxicity, handling, mixing, and application, as well as recommended treatments in case of accidents. Read and become

By law, all registered pesticide labels must contain:

1. **Brand, trade, or manufacturer's name**—usually the most conspicuous name on the label
2. **Common or generic name**—refers to the active ingredient
3. **Formulation type**—e.g., granules, dusts, liquids, emulsifiable concentrates, etc.
4. **Ingredient statement**—the percentages, by weight, of the active and inert ingredients
5. **Net contents of the container**
6. **Manufacturer's name and address**
7. **EPA registration number**
8. **Establishment number**—identifies the facility that manufactured the material
9. **Use classification**—specifies either general or restricted use
10. **Signal words and symbols:**  
DANGER-POISON—highly toxic materials

All products must also bear the statement KEEP OUT OF REACH OF CHILDREN.

11. **Precautionary statement**—describes any physical or chemical hazards to humans, domestic animals, or the environment.
12. **First aid measures**—in case of accidental exposure.
13. **Directions for use**—how to mix and apply the pesticide, the site, host, and pest(s) for which it is registered, how much to use, and when to use it.
14. **Misuse statement**—warns against use that is not consistent with label directions.
15. **Re-entry statement**—defines, if necessary for the product, the waiting period to observe before you can safely re-enter the treated area without protective clothing.
16. **Directions for storage and disposal** of the material and empty containers.

[illegible]



### *Toxicity*

Pesticides fall into four categories of toxicity. A quick glance at the *signal word* on the label will tell you which category of chemical you are handling. The following table summarizes and compares the categories.

Classification	Signal Words	Average Lethal Dose
CATEGORY I Very high toxicity	Danger-Poison	Taste–tsp
CATEGORY II High Toxicity	Warning	Tsp–tbsp
CATEGORY III Moderate toxicity	Caution	Oz–pint
CATEGORY IV Low toxicity	None-Minimal hazard	Pint–qt or more

### *Exposure*

- **Acute**—A single exposure to a pesticide.
- **Chronic**—Repeated or continuous exposure to a pesticide.

### *Entry Routes*

- **Skin** (dermal)—Pesticides are most commonly absorbed through the skin, and most rapidly absorbed through the genital area and mucous membranes. Liquids are the most readily absorbed type of formulation.
- **Mouth** (oral)—Swallowing pesticides can cause serious illness, injury, or death.
- **Lungs** (inhalation)—Inhaling pesticides can severely damage nose, throat, and lung tissues. Total hazard is great because these tissues rapidly absorb pesticides.
- **Eyes** (ocular)—The sensitive tissues of the eyes are very absorbent, so hazard is great.

### **Pesticide Safety**

Safety should be a concern before and after as well as during pesticide application. To avoid possible health and environmental hazards, use the following checklist of precautions to plan, conduct, and close your control operations.

### *Planning*

When drawing up a safety plan, consider the following:

- size of area to be treated
- target pest and host plant
- possible damage to non-target plants or animals, e.g., bees, birds, fish, and nearby trees
- active ingredient, formulation, and application method
- quantities of pesticides and additives (e.g., “thickeners”) needed (remember—leftover pesticide may create disposal problems)
- storage and mixing facilities
- special equipment for safe mixing and application
- protective equipment and clothing
- first aid supplies
- operating procedures at the mixing and loading area
- monitoring for exposure to pesticides
- emergency procedures in case of an accident or spill
- location and phone number of medical facilities in case of an accident
- cleanup and decontamination procedures
- disposing of unused pesticides and empty containers

### *Storage*

Store pesticides in their original, labeled containers in a locked building until you are ready to apply them. Make sure the facility is well lighted, ventilated, and away from foods, animal feeds, and seeds. Keep fire extinguishers handy and post warning signs on the outside of the building. Periodically inspect containers for corrosion and leakage. Separate herbicides from other pesticides when storing to prevent cross-contamination.



### **Handling, Mixing, and Loading**

Pouring and mixing chemical concentrates can be very dangerous. Here are some commonsense rules that will make these tasks safer:

- Read the safety information on the label.
- Use the proper protective equipment and clothing (see "Safety Equipment").
- Keep plenty of clean water available for rinsing.
- Do not work alone.
- Do not eat or smoke while handling pesticides.
- Mix outdoors where ventilation and lighting are good.
- Be sure you and other people are upwind when pouring.
- Keep containers below eye level while pouring to avoid splashing pesticide on your face or in your eyes. When pouring from an unvented can, keep opening at top.
- If pesticides are splashed or spilled, quickly remove contaminated clothing, wash skin thoroughly with soap and water, put on clean, protective clothing, and then clean up the spill.

### **Application**

When applying pesticides:

- Use appropriate protective equipment and clothing.
- See that equipment is in good repair and operating properly. Inspect for loose connections, leaking hoses or pumps, and dirty or dripping nozzles.
- Mix pesticides and additives properly, according to label directions.
- Adjust calibration so that the right amount of pesticide is applied.
- Do not apply insecticides or fungicides with equipment used to apply herbicides. Sprayers should be labeled by type of pesticide applied.

### **Disposal**

Check the label for special disposal instructions. Thoroughly flush used equipment with plenty of clean water and, where possible, triple-rinse empty containers and then recycle them through the manufacturer. If this is not possible, puncture or crush rinsed containers and then bury them (at least 18 in. deep), or take them to a sanitary landfill for disposal. If possible, use the rinse water to dilute future batches of spray mix, or just spray it on target trees. If this is not possible, ask your local county extension agent about local disposal guidelines and/or restrictions.

If you must dispose of unused, undiluted pesticides, you should get help from your pesticide supplier, your county extension agent, or the Environmental Protection Agency. Avoid disposal problems by planning for and buying only as much pesticide as you need.

### **Spills**

Clean up spills as soon as they happen. First, protect yourself from exposure; then, contain the spill with a barrier of sawdust, kitty litter, or soil. If the spill is indoors, be sure there is adequate ventilation. Check label for specific decontamination instructions. Many pesticides can be detoxified with water mixed with detergents and/or bleach. If the spill looks too big to handle, call the manufacturer at the emergency telephone number on the label. If this is unsuccessful, you may contact a team of specialists from the National Agricultural Chemicals Association (NACA) by calling a 24-hour, toll-free number (1-800-424-9300). If necessary, they will even send a safety team to assist in the cleanup.

### **Pesticide Poisoning**

Symptoms of pesticide poisoning may be barely noticeable or dramatic, depending on the dose absorbed. Project personnel should be able to recognize symptoms, gauge severity of poisoning, and be familiar with emergency first aid procedures.

#### **Poisoning Symptoms**

**Mild Poisoning** can produce fatigue, headache, dizziness, numbness in the hands and feet, nausea and vomiting, excessive sweating, salivation, abdominal cramps, and diarrhea.

**Moderate Poisoning** can produce most of the symptoms listed for mild poisoning as well as the inability to walk, difficulty talking, muscular twitching, general weakness, and contracted pupils.

**Severe Poisoning** can cause all of the above symptoms as well as extreme shrinking of the pupils, secretions from the mouth and nose, convulsions, difficulty breathing, and unconsciousness. If victims of severe poisoning are not treated immediately, they usually die.



## Emergency Action

1. Move victim away from the pesticide, remove any contaminated clothing, and thoroughly wash off pesticides.
2. Start first aid (see below). If breathing has stopped, give artificial respiration. Keep victim quiet, warm, and comfortable. Call ahead to alert a physician, do not stop first aid.
3. Administer two atropine tablets (by prescription only) if victim is conscious and symptoms are of moderate or severe poisoning by organophosphate or carbamate pesticides.
4. Rush victim to a doctor or hospital. **REMEMBER:** always take a *pesticide label* along with the victim. Tell the doctor if atropine has been given.

## First Aid

**ON THE SKIN**—Rip off contaminated clothing; flush affected areas thoroughly with running water, and then wash with soap and water.

**IN THE EYES**—Hold eyelids open and flush eyes with a gentle stream of clean, running water for at least 15 minutes. Boric acid solution may also be used.

**INHALED**—Immediately move victim to an open area, preferably outdoors, to get fresh air. The rescuer should wear protective respiratory equipment. Give artificial respiration if necessary.

**SWALLOWED**—If the pesticide label says to induce vomiting, give two table-spoons of salt in a glass of warm water only if the individual is conscious. Do not induce vomiting if the swallowed poison is a strong acid, a strong alkali, or a concentrated petroleum formulation mixed in kerosene, gasoline, fuel oil, etc. If recommended on the label, give an antidote. **NOTE:** Never give anything by mouth to an unconscious person.

**Universal Antidote** (mix 1/2 oz in 1/2 glass of water)

Two parts activated charcoal

One part magnesium oxide

One part tannic acid

**Antidote for corrosive chemicals:**

Acidic—1 tbsp milk of magnesia in one cup of water

Alkaline—1 qt of milk

**CHEMICAL BURNS**—Remove contaminated clothing; flush skin with large amounts of water, and then loosely cover the affected area with a clean dressing. Do not apply any medications to the affected area.

**After first aid, carry out emergency action step 3.**



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### **Poison Control Centers**

The "800" numbers listed below are for use only within the specific State involved. The State coordinators are primarily administrative; for emergencies, contact the Regional Poison Control Centers or Hospital Poison Control Centers first. Address all correspondence or phone calls to the "Poison Control Center" of that organization.

#### **ILLINOIS**

State Coordinator  
Division of Emergency Medical  
Services and Highway Safety  
Springfield, IL 62761  
(217) 785-2080

Rush Presbyterian/St. Luke's  
Medical Center  
1753 W. Congress Parkway  
Chicago, IL 60612  
(312) 942-5969  
800-942-5969

St. Francis Hospital and Medical  
Center  
530 N.E. Glen Oak Avenue  
Peoria, IL 61637  
(309) 672-2334  
800-322-5330

St. John's Hospital  
800 East Carpenter  
Springfield, IL 62702  
(217) 753-3330  
800-252-2022

#### **INDIANA**

State Coordinator  
State Board of Health  
Indianapolis, IN 46206  
(317) 633-0332

St. Catherine's Hospital  
4321 Fir Street  
East Chicago, IN 46312  
(219) 392-1700  
(219) 392-7203

Elkhart General Hospital  
600 E. Boulevard  
Elkhart, IN 46514  
(219) 294-2621  
800-382-9697

St. Joseph's Hospital  
700 Broadway  
Fort Wayne, IN 46802  
(219) 423-2614

Indiana Poison Center  
1001 West 10th Street  
Indianapolis, IN 46202  
(317) 630-7351  
800-382-9097

Lafayette Home Hospital  
2400 South Street  
Lafayette, IN 47902  
(317) 447-6811

#### **IOWA**

State Coordinator  
Department of Health  
Des Moines, IA 50319  
(515) 281-4964

Iowa Methodist Hospital  
1200 Pleasant Street  
Des Moines, IA 50308  
(515) 283-6254  
800-362-2327

Mercy Medical Center  
Mercy Drive  
Dubuque, IA 52001  
(319) 588-8050

University of Iowa Hospital  
Poison Information Center  
Iowa City, IA 52240  
(319) 356-2922  
800-272-6477

#### **MICHIGAN**

State Coordinator  
Department of Public Health  
Lansing, MI 48909  
(517) 373-1406

University Hospital  
1405 E. Ann Street  
Ann Arbor, MI 48104  
(313) 764-5102

Southeast Regional Poison Center  
Children's Hospital of Michigan  
3901 Beaubien  
Detroit, MI 48201  
(313) 494-5711  
800-572-1655  
800-462-6642

Western Michigan Regional Poison  
Center  
1840 Wealthy, S.E.  
Grand Rapids, MI 49506  
(616) 774-7851  
800-442-4571  
800-632-2727

Midwest Poison Center  
Borgess Medical Center  
1521 Gull Road  
Kalamazoo, MI 49001  
(616) 383-7070  
800-632-4177

Marquette General Hospital  
420 W. Magnetic Drive  
Marquette, MI 49855  
(906) 228-9440  
800-562-9781

Munson Medical Center  
Sixth Street  
Traverse City, MI 49684  
(616) 947-6140

#### **MINNESOTA**

State Coordinator  
State Department of Health  
Minneapolis, MN 55404  
(612) 623-5281

St. Joseph's Hospital  
Brainerd, MN 56401  
(218) 829-2861 Ext. 211

St. Luke's Hospital  
Emergency Department  
915 E. First Street  
Duluth, MN 55805  
(218) 727-6636

Southeastern Minnesota Poison  
Control Center  
St. Mary's Hospital  
1216 Second Street, S.W.  
Rochester, MN 55901  
(507) 285-5123 Ext. 517

St. Paul Ramsey Hospital  
640 Jackson Street  
St. Paul, MN 55101  
(612) 221-2113  
800-222-1222

#### **MISSOURI**

State Coordinator  
Missouri Division of Health  
Jefferson City, MO 65102  
(314) 751-2713

University of Missouri Medical  
Center  
807 Stadium Blvd.  
Columbia, MO 65201  
(314) 882-8091

St. John's Medical Center  
2727 McClelland Blvd.  
Joplin, MO 64801  
(417) 781-2727 Ext. 2305



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Children's Mercy Hospital  
24th and Gillham Road  
Kansas City, MO 64108  
(816) 234-3000

Cardinal Glennon Memorial Hospital  
for Children  
1465 S. Grand Avenue  
St. Louis, MO 63104  
(314) 772-5200  
800-392-9111

Ozark Poison Center  
Lester E. Cox Medical Center  
1423 N. Jefferson Street  
Springfield, MO 65802  
(417) 831-9746  
800-492-4824

#### OHIO

State Coordinator  
Department of Health  
Columbus, OH 43216  
(614) 466-5190

Children's Hospital  
281 Locust  
Akron, OH 44308  
(216) 379-8562  
800-362-9922

Drug and Poison Information Center  
University of Cincinnati Medical  
Center  
231 Bethesda Avenue  
Cincinnati, OH 45267  
(513) 872-5111

Academy of Medicine  
11001 Cedar Avenue  
Cleveland, OH 44106  
(216) 231-4455

Ohio Poison Center  
Children's Hospital  
700 Children's Drive  
Columbus, OH 43205  
(614) 228-1323

Poison Information Center  
Medical College Hospital  
P.O. Box 6190  
Toledo, OH 43679  
(419) 381-3897

Mahoning Valley Poison Control  
Center  
St. Elizabeth Hospital and Medical  
Center  
1044 Belmont Avenue  
Youngstown, OH 44501  
(216) 746-2222

#### PENNSYLVANIA

State Coordinator  
Director, Division of Epidemiology  
Department of Health  
P.O. Box 90  
Harrisburg, PA 17108  
(717) 787-2307

Lehigh Valley Poison Center  
17th and Chew Street  
Allentown, PA 18102  
(215) 433-2311

Altoona Region Poison Center  
Mercy Hospital  
2500 Seventh Avenue  
Altoona, PA 17815  
(814) 946-3711

Susquehanna Poison Center  
Geisinger Medical Center  
North Academy Avenue  
Danville, PA 17821  
(717) 275-6116

Northwest Poison Center  
St. Vincent Health Center  
P.O. Box 740  
Erie, PA 16512  
(814) 452-3232

Capitol Area Poison Center  
Milton S. Hershey Medical Center  
University Drive  
Hershey, PA 17033  
(717) 534-6111  
(717) 534-8955

Cambria-Somerset Poison Center  
Lee Hospital  
320 Main Street  
Johnstown, PA 15901  
(814) 535-5352

Philadelphia Poison Information  
321 University Avenue  
Philadelphia, PA 19104  
(215) 922-5523  
(215) 922-5524

Children's Hospital  
125 DeSoto Street  
Pittsburgh, PA 15213  
(412) 681-6669

#### WISCONSIN

State Coordinator  
Department of Health and Social  
Services  
Division of Health  
Madison, WI 53701  
(608) 267-7174

Green Bay Poison Control Center  
St. Vincent Hospital  
835 S. Van Buren Street  
Green Bay, WI 54305  
(414) 433-8100

Madison Area Poison Center  
University Hospital and Clinic  
600 Highland Avenue  
Madison, WI 53792  
(608) 262-3702

Milwaukee Children's Hospital  
1700 W. Wisconsin  
Milwaukee, WI 53233  
(414) 931-4114



## Equipment

### Safety Equipment

Safety equipment needs will vary depending on the pesticide, so check the label for specific requirements. At a minimum, persons handling pesticides should wear a liquid-proof, full-brimmed hat and coveralls over a long-sleeved shirt and full-length pants. When handling pesticide concentrates and highly or moderately toxic materials, you should also wear liquid-proof gloves, boots, apron, face shield, and goggles.

Generally, the more toxic the material, the greater the need for additional specialized protection, such as dust masks and respirators. Consult the pesticide label and equipment manufacturers to help choose protective devices that will fit your needs. Here is some basic protective gear.

- **Goggles**—Non-fogging, sized to fit over eyeglasses.
- **Face Shields**—Especially important when mixing toxic concentrates.
- **Dust Masks**—To filter particle matter such as dust out of breathing air.
- **Respirators, Gas Masks, Self-Contained Breathing Apparatus, and Hooded Respirators**—To remove particles, toxic gases, and odor from breathing air.
- **Gloves**—Made of unlined neoprene, PVC, or natural rubber. CAUTION: Check label to make sure the choice of material is compatible with the pesticide being used. Some fumigants are readily absorbed by neoprene, and some chemicals will penetrate or break down natural rubber.
- **Boots**—Liquid-proof, same materials as gloves. Knee length is best so the apron overlaps boot tops and prevents material from dripping into the boots.
- **Aprons**—Liquid-proof, made of PVC or neoprene. Important when mixing pesticides, particularly the more toxic ones.

- **Hats**—Full-brimmed, washable plastic or fiberglass with washable or disposal sweatband. Hard hats are good.
- **Rainsuits or Coveralls**—Neoprene or PVC with waterproof seams. Important when mixing and applying with hand pumps and backpack-type sprayers. Wear disposable coveralls when handling very toxic materials.
- **First Aid Kit**—Keep these items readily available at the work site:
  1. a supply of clean water
  2. soap or detergent
  3. disposable wash cloths
  4. salt
  5. syrup of ipecac
  6. milk of magnesia
  7. baking soda
  8. lemon juice or vinegar
  9. universal antidote (see "First Aid")
  10. boric acid solution
  11. eye cup
  12. a shaped, plastic airway for mouth-to-mouth resuscitation
  13. Atropine tablets (check with a local physician for a prescription)
  14. bandages and dressing materials
  15. blankets

### Mixing and Transfer Equipment

A large variety of equipment is available for safe mixing and transfer of pesticides. The following list is not exhaustive but briefly describes the more important pieces of equipment:

- **Mixing Tanks**—manufactured from stainless steel, steel with a bonded liner, fiberglass, polyethylene, or aluminum. Be sure to choose material compatible with the pesticides you use.
- **Agitators**—mechanical or recirculating jets used in the mixing tank. Consider bypass and pressure capacities when choosing recirculating agitators.
- **Pumps**—used for transferring mixed and unmixed materials. Piston, roller, diaphragm, and centrifugal pumps have different pressure and volume capabilities.

- **Strainers**—in-line filters between the mixing tank and the sprayer, designed to remove particles and foreign material that could clog the nozzles. Common meshes are 40, 80, and 100.
- **Hoses**—come in several sizes and pressure ratings. Volumes, pumping pressures, and pesticides used will dictate your choice.
- **Valves**—particularly important in recirculating jet agitators; also control the flow of material into and out of the mixing tank.
- **Measuring Equipment**—essential when preparing formulations for application. Smaller jobs may be handled with cups or buckets. You may want to consider metering pumps if you regularly prepare a large amount of material.

### Application Equipment

Your choice of application equipment will depend on the target pest, the part of the tree affected, the size and distribution of the infestation, and the pesticide to be applied. Ask an equipment manufacturer for literature on the following products.

- **Hand Pump Sprayers** carry 1 to 4 gallons and are ideal for treating small, scattered infestations.
- **Backpack (or Knapsack) Pump Sprayers** normally carry 5 gallons. Good for small infestations and easier to carry than the hand pump sprayer.
- **Backpack Mist Blowers** can treat larger areas than hand pumps or backpack sprayers can.
- **Tractor PTO Sprayer** driven by the power take-off on a tractor. Spray tank capacities range from 50 to 600 gallons. For large projects, use long booms and/or mist blowers.
- **Skid-Mounted Sprayers** normally drawn on a trailer and powered by gasoline engine pumps. Capacities and capabilities are similar to those of the tractor PTO sprayers.



- Aerial Spraying** normally contracted out to professionals who use helicopters or fixed-wing spray planes. Aerial application is usually not economical unless the area to be treated is very large.

As with the mixing and transfer equipment, spray equipment and accessories are manufactured from various materials including steel, stainless steel, aluminum, brass, and nylon. Be sure this material is compatible with the pesticides you are using. For instance, Bordeaux mixture is a corrosive compound that requires fiberglass or stainless steel tanks. Be sure to tell the manufacturer what pesticides you will be applying before you purchase equipment.

### Calibration

Application equipment must be calibrated, or adjusted, to deliver a specified amount of pesticide to a given area. Calibration is a trial-and-error process of measuring, adjusting, and remeasuring the amount of pesticide delivered until you reach the desired flow rate. Rates are expressed in gallons per acre, gallons per minute, gallons per hour, or some other set measure.

The flow rate varies according to the size, number, and type of nozzles, boom width, pump pressure, and the speed of the sprayer. You can determine flow rate by simply measuring the time it takes for a stream of pesticide from the applicator to fill a receptacle of known volume. You can then change flow rate by resetting pump pressure, adding or taking off nozzles, changing orifice size, and/or adjusting the traveling speed of the sprayer.

The success of your treatment will depend on how accurate this setting is. Inaccurate calibration will "tell" your equipment to deliver too much or not enough pesticide to your trees. To find out more about this important phase of pesticide application, contact the manufacturer of your equipment.

### A Partial List Of Safety Equipment Sources

The use of firm or corporation names in the following list is solely for the information and convenience of the reader. This list is by no means exhaustive and does not constitute an official recommendation or endorsement of any products or services to the exclusion of those offered by other companies.

Agrotec, Inc.  
Spearin Road, Box 215,  
Salisbury, MD 21801-0215  
1,2,3,4,5,6,7\*

American Optical Corp.  
Safety Products Div.  
14 Mechanic St.  
Southbridge, MA 01550  
4,5,6,7

Cal-Mil Plastics Products, Inc.  
6100 Paseo Del Norte  
Carlsbad, CA 92008  
1,2,7

Cesco Safety Products  
100 East 16th Street  
Kansas City, MO 64108  
1,4,5,6,7

Coastal Ag-Chem Corp.  
P.O. Box 1307  
Oxnard, CA 93032  
2,3,4,5,6,7

Cornbelt Chemical Co.  
North Hwy. 83, Box 410  
McCook, NE 69001  
2,3,4,5,6,7

Crown Chemicals Co.  
4235 Duncan Ave.  
St. Louis, MO 63110  
2,4,6,7

General Scientific Equipment Co.  
Limekiln Pike & Williams Ave.  
Philadelphia, PA 19150  
1,2,3,4,5,6,7

Goodall Rubber Co.  
P. O. Box 8237  
Trenton, NJ 08650  
2,3,4,5,6,7

Mine Safety Appliances Co.  
600 Penn Center Blvd.  
Pittsburgh, PA 15235  
1,2,3,4,5,6,7

Occupational Safety Marketing Div.  
ESB, Inc.  
P.O. Box 622  
Reading, PA 19603  
1,2,3,4,5,6,7

Personal Environment Systems, Inc.  
P. O. Box 800  
Glendale, CA 91209  
1,2,4,5,6,7

Pulmosan Safety Equipment Corp.  
30-48 Linden Place  
Flushing, NY 11354  
1,2,3,4,5,6,7

M. L. Snyder & Sons, Inc.  
221 West First Street  
Kewanee, IL 61443  
2,3,4,5,6,7

3M Company  
3M Center  
St. Paul, MN 55101  
1,5,6,7

United States Plastic Corp.  
Tamco Industrial Park  
1390 Neubrecht Road  
Lima, OH 45801  
2,3,4,5,6,7

Van Waters & Rogers  
P. O. Box 5932  
San Mateo, CA 94403  
2,3,4,5,6

Willson Products Div.  
ESB, Inc.  
P. O. Box 622  
Reading, PA 19603  
3,4,5,6,7

Woodbury Chemical Co.  
13690 SW 248th Street  
P. O. Box 4319  
Princeton, FL 33032  
2,3,4,5,6,7

York Chemical Co., Inc.  
195 Atlantic Ave.  
Garden City Park  
Long Island, NY 11040  
3,4,5,6

### \*Product Codes

1. Air helmets
2. Protective clothing
3. Gloves
4. Goggles
5. Hats
6. Masks, respirators, and gas masks
7. Personnel protective equipment

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***A Partial List of Handling, Mixing,  
and Application Equipment Sources***

Acme Burgess  
Route 83  
Grayslake, IL 60030  
2,3\*

Ag-Chem Equipment Co., Inc.  
4900 Viking Drive  
Minneapolis, MN 55435  
7,8,9,11,12

Agro-Chem, Inc.  
11150 Addison  
Franklin Park, IL 60131  
3,6,7,8,9,10,11,12

Agrotec, Inc.  
Spearin Road Box 215  
Salisbury, MD 21801-0215  
2,4,5,6,7,8,9,10,11

Allis-Chalmers  
Box 512  
Milwaukee, WI 53201  
13

Automatic Equipment Mfg. Co  
P.O. Box P  
Pender, NE 68047  
6,7

John Blue Co.  
2800 Bob Wallace Avenue  
Huntsville, AL 35805  
1,6,7,11,12,14

Bolens-FMC Corp.  
Outdoor Power Equipment Div.  
215 S. Park Street  
Port Washington, WI 53074  
13

The Broyhill Co.  
N. Market Square  
Dakota City, NE 68731  
6,7,10,11,12

Buffalo Turbine Ag. Equip. Co., Inc.  
70 Industrial Street  
Gowanda, NY 14170  
1,5,6,7

J. I. Case, Construction Equip. Div.  
700 State Street  
Racine, WI 53404  
13

R. E. Chapin Mfg. Works, Inc.  
29 Liberty Street  
Batavia, NY 14020  
1,3,4

Cushman/OMC Lincoln  
Box 82409  
Lincoln, NE 68501  
6

Deere and Company  
John Deere Road  
Moline, IL 61265  
13

Delavan Corp.  
Box 100  
West Des Moines, IA 50265  
10,11

The J. J. Dill Co.  
Box 788  
Kalamazoo, MI 49005  
2,11,12

Earthway Products, Inc.  
Box 547  
Bristol, IN 46507  
1,3

Encap Products Co.  
Box 278  
Mt. Prospect, IL 60056  
1,5,7,8,9,11

FMC Corp., Ag. Machinery Div.  
5601 E. Highland Drive  
Jonesboro, AR 72401  
6,7,8,9,10,11

Fairmont Steel Products  
Redi Haul Trailers Div.  
517 Winnebago Avenue  
Fairmont, MN 56031  
14

Ford Motor Co., Tractor & Implement  
Operations  
2500 E. Maple Road  
Troy, MI 48084  
4

Gilmour Mfg. Co.  
Box 486  
Somerset, PA 15501  
3,8,9,10

Gravely  
One Gravely Lane  
Clemmons, NC 27012  
13,14

Hanson Equipment Co.  
301 Charles Street  
South Beloit, IL 61080  
6,7,10,11

Homelite, Div. of Textron, Inc.  
Box 7047  
Charlotte, NC 28217  
4,11

H. D. Hudson Mfg. Co.  
500 N. Michigan Avenue  
Chicago, IL 60611  
1,3,4,5,6,7,8,9,11

Jacobsen Division of Textron, Inc.  
1721 Packard Avenue  
Racine, WI 53403  
13

Johnson Mfg. Co., Inc.  
Box 49  
Pendleton, NC 27862  
7,8,9,10,11

Kim Mfg. Co.  
1407 Kansas Avenue  
Kansas City, MO 64127  
11,12

Kubota Tractor Corp.  
Box 7020  
Compton, CA 90224  
13

Kuker Industries, Inc.  
Box 37589  
Omaha, NE 68137  
6,7,8,9,10,11,12

Lakeshore Equipment & Supply Co.  
Lesco Products Division  
300 S. Abbe Road  
Elyria, OH 44035  
7,8,9,10,11

Larson Machine Inc.  
Box 308  
Princeville, IL 61559  
6,7,10,11

Leigh Products, Inc.  
Universal-Gerwin Division  
460 Main Street  
Saranac, MI 48881  
1,3,4,11

The Lely Corp.  
Box 1060  
Wilson, NC 27893  
10,11,12

Massey-Ferguson, Inc.  
1901 Bell Avenue  
Des Moines, IA 50315  
13

Master Mfg. Co.  
Box 694  
Sioux City, IA 51102  
6,7,11



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Midwest Industrial Supply, Inc.  
Box 8431  
Canton, OH 44711  
4,5,12

Minnesota Wanner Co.  
5145 Eden Avenue South  
Minneapolis, MN 55436  
7,10,11

Mitsubishi Tractors  
22H Craigwood Road  
Avenel, NJ 07001  
13

F. E. Myers Co.  
400 Orange Street  
Ashland, OH 44805  
6,7,10,11

Parco Div.  
Blue Mountain Products, Inc.  
Box 250  
New Hartford, NY 13413  
1,3,8,9,10,11

Pex, Inc.  
Box 272  
Hiawatha, KS 66434  
7,8,9,10,11

Rokor, Inc.  
Box 1409  
Wilson, NC 27893  
14

Root-Lowell Corp.  
1000 Foreman Road  
Lowell, MI 49331  
1,2,3,4,7

D. B. Smith Co., Inc.  
414 Main Street  
Utica, NY 13503  
1,4,10,11

Smithco, Inc.  
11 West Avenue  
Wayne, PA 19087  
7,11

Snowco  
4350 McKinley Street  
Omaha, NE 68112  
14

Solo Incorporated  
Box 5030  
Newport News, VA 23605  
1,3,4,5,11

Spraying Systems Co.  
North Ave. at Schmale Road  
Wheaton, IL 60187  
8,10

Stihl Inc.  
536 Viking Drive  
Virginia beach, VA 23452  
5

Tuflex Mfg. Co.  
Box 13143  
Port Everglades, FL 33316  
7,10,11,12

United Farm Tools, Inc.  
Lawn and Garden Division  
Box 9175  
South Charleston, WV 25309  
7,8,9,10,11

Vandermolen Corp.  
119 Dorsa Avenue  
Livingston, NJ 07039  
1,4,5

W-W Grinder, Inc.  
Box 4029  
Wichita, KS 67204  
6,7

Westheffer Turf Division  
Box 363  
Lawrence, KS 66044  
3,4,5,7,8,9,10,11,12

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**\*Product Codes**

1. Dusters
2. Foggers
3. Hand pump sprayers
4. Hand pump backpack sprayers
5. Backpack mist blowers
6. Tractor-mounted PTO sprayers
7. Skid-mounted power sprayers
8. Couplings
9. Hoses
10. Nozzles
11. Pumps
12. Tanks
13. Tractors, rubber-wheeled
14. Trailers, utility

## Pesticide Table

This table is based on pesticides that are federally registered for use on Christmas tree pests. However, pesticide regulations in your state may prohibit the use of some of these materials. If you are unsure about which pesticides to use, contact your county extension agent or pest specialist.

The dark bars on the table indicate the most effective time to apply pesticides, and the striped bars represent other times you can apply pesticides although they may be less effective (see examples below).

### Disease Example

DORM*	APR	1. MAY	JUN	2. JUL	AUG	SEP	OCT
-------	-----	--------	-----	--------	-----	-----	-----

1. The best time to apply a preventive fungicide to needles is *before* spores are released. The effective spray period is spread over several weeks to illustrate the early protection needed in southern areas and the later protection time in northern areas.

2. A spray during this period will offer some protection but may not be as effective as an early spray. Infection may have already taken place by this time.

### Insect Example

DORM*	1. APR	2. MAY	JUN	JUL	3. AUG	SEP	OCT
-------	--------	--------	-----	-----	--------	-----	-----

1. The best time to spray larvae that are emerging after overwintering.  
2. Emerging larvae may also be treated at this time but treatment may be less effective.  
3. Larvae hatching from this year's eggs may be sprayed during this period.

\*Dorm. = November to March, when trees are in a "dormant", or inactive stage.

Because optimum timing for a given pest varies with differences in season and latitude, it is a good idea to check with your county extension agent or pest specialist when scheduling control treatments.

Only common names of pesticides are used in the table, but a common name/trade name cross-reference can be found on page 101.

This information is supplied with the understanding that no discrimination is intended and no endorsement by the USDA Forest Service is implied. The authors have assembled the most reliable information available at the time of publication. Due to constantly changing laws and regulations, the USDA Forest Service can assume no liability for this information.

### Adana tip moth

azinphos-methyl  
carbophenothion  
dimethoate

lindane  
trichlorfon

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT
-------	-----	-----	-----	-----	-----	-----	-----

### Allegheny mound ant

carbaryl  
chlorpyrifos

diazinon  
fenthion

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT
-------	-----	-----	-----	-----	-----	-----	-----

### Anomala beetle (see pine chafer.)

**Aphids** (See also Cooley spruce gall aphid, eastern spruce gall aphid, spotted pine aphid, and white pine aphid.)

acephate  
azinphos-methyl  
carbophenothion  
chlorpyrifos  
demeton  
diazinon  
dimethoate  
disulfoton  
dormant oils

Dymet\*  
endosulfan  
insecticidal soap  
lindane  
malathion  
monocrotophos  
naled  
oxydemeton-methyl  
superior oil

\*"Dymet" is a registered trademark of Mallinckrodt, Inc. It is a mixture of diazinon and methoxychlor.

1. DORM.	2. APR	MAY	JUN	JUL	AUG	SEP	OCT
----------	--------	-----	-----	-----	-----	-----	-----

1. Use dormant or superior oils.  
2. Use other chemical pesticides.

### Armillaria root rot (shoestring root rot)

No pesticide treatment recommended.

### Bagworm

acephate  
*Bacillus thuringiensis* (Bt)\*  
carbaryl  
chlorpyrifos

diazinon  
dimethoate  
malathion  
trichlorfon

\*A biological control agent. Apply only between late May and early July.

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT
-------	-----	-----	-----	-----	-----	-----	-----

### Balsam gall midge

carbaryl  
diazinon  
dimethoate

lindane  
malathion  
naled

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT
-------	-----	-----	-----	-----	-----	-----	-----

See text for timing relative to shoot length.

### Brown spot needle blight

Bordeaux mixture  
chlorothalonil

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT
-------	-----	-----	-----	-----	-----	-----	-----

**Budworms** (See spruce budworm and jack pine budworm.)

### Cedar-apple rust

cycloheximide  
ferbam

DORM.	APR	1. MAY	JUN	JUL	2. AUG	SEP	OCT
-------	-----	--------	-----	-----	--------	-----	-----

1. Spray orange jellylike galls with cycloheximide.  
2. Spray redcedar with ferbam.

NOTE: Application time varies with weather, geographic location, chemical formulation, and insect and disease development. Check with a local pest specialist for proper timing, and read label carefully before using pesticide.



### Cooley spruce gall aphid

carbaryl  
demeton  
dormant oil  
endosulfan

insecticidal soap  
lindane  
malathion  
superior oil

1. DORM.	2. APR	MAY	JUN	JUL	AUG	SEP	OCT
-------------	-----------	-----	-----	-----	-----	-----	-----

1. Use dormant or superior oils.
2. Use other chemical pesticides.

### Cytospora canker

No pesticide treatment recommended.

### Deer

#### Repellents:

bone tar oil  
capsaicin

putrescent egg solids  
(commercial preparation)  
thiram

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT
-------	-----	-----	-----	-----	-----	-----	-----

Deer injury is most likely to occur during the winter.

### Diplodia shoot blight and canker

benomyl  
Bordeaux mixture

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT
-------	-----	-----	-----	-----	-----	-----	-----

### Dothistroma needlecast

Bordeaux mixture  
copper salts

DORM.	APR	1. MAY	2. JUN	JUL	AUG	SEP	OCT
-------	-----	-----------	-----------	-----	-----	-----	-----

1. To protect previous year's needles. This spray is optional.
2. To protect new and previous year's needles.

### Eastern pine shoot borer

carbophenothion  
demeton

diazinon  
malathion

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT
-------	-----	-----	-----	-----	-----	-----	-----

### Eastern spruce gall aphid

carbaryl  
demeton  
insecticidal soap

lindane  
malathion

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT
-------	-----	-----	-----	-----	-----	-----	-----

### Eriophyid mites

Carbaryl  
chlorpyrifos  
demeton  
diazinon  
naled

dicofol  
dimethoate  
malathion  
phorate  
trichlorfon

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT
-------	-----	-----	-----	-----	-----	-----	-----

### European pine sawfly

acephate  
carbaryl  
Dymet  
insecticidal soap

monocrotophos  
malathion  
virus preparation\*

\*A biological control agent.

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT
-------	-----	-----	-----	-----	-----	-----	-----

### European pine shoot moth

azinphos-methyl  
carbaryl  
carbophenothion

dimethoate  
diazinon  
malathion

DORM.	1. APR	MAY	JUN	2. JUL	AUG	SEP	OCT
-------	-----------	-----	-----	-----------	-----	-----	-----

1. To control larvae emerging after overwintering.
2. To control this year's hatching larvae.

### Gall rusts

ferbam  
zineb

ziram

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT
-------	-----	-----	-----	-----	-----	-----	-----

Timing will vary depending on the type of rust.

1. To control pine-pine (western) gall rusts.
2. To control other gall rusts.

### Grass (See weeds, grass.)

### Grasshoppers

carbaryl  
carbophenothion  
chlorpyrifos  
dimethoate  
ethion

lindane  
malathion  
methomyl  
naled  
phorate

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT
-------	-----	-----	-----	-----	-----	-----	-----

### Gypsy moth

acephate  
*Bacillus thuringiensis*  
(Bt)\*  
carbaryl

creosote (eggs only)  
methoxychlor  
trichlorfon

\*A biological control agent.

DORM.	1. APR	MAY	JUN	2. JUL	AUG	SEP	OCT
-------	-----------	-----	-----	-----------	-----	-----	-----

1. To control larvae.
2. To control adults.

### Introduced pine sawfly

acephate  
carbaryl  
Dymet

insecticidal soap  
malathion  
monocrotophos

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT
-------	-----	-----	-----	-----	-----	-----	-----

Spray period includes control of two overlapping generations.

### Jack pine budworm

acephate  
*Bacillus thuringiensis*  
(Bt)\*  
carbaryl  
endosulfan

insecticidal soap  
malathion  
naled  
trichlorfon

\*A biological control agent.

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT
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### Jack pine tip beetle

No pesticide treatment recommended.

NOTE: Application time varies with weather, geographic location, chemical formulation, and insect and disease development. Check with a local pest specialist for proper timing, and read label carefully before using pesticide.

### Lophodermium needlecast

Bordeaux mixture      maneb  
chlorothalonil

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT

### Mouse

#### Baits

strychnine      zinc phosphide  
warfarin

### Repellents

capsaicin      thiram

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT

Injury is most likely to occur in the winter.

### Naemacyclus needlecast

benomyl      maneb  
chlorothalonil

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT

Treatment may be needed through mid-November.

### Nantucket pine tip moth

azinphos-methyl      lindane  
carbophenothion      trichlorfon  
dimethoate

DORM.	APR	1. MAY	2. JUN	JUL	AUG	SEP	OCT

1. To control first generation larvae.
2. To control additional generations.

### Northern pine weevil

lindane      bendiocarb  
naled

DORM.	1. APR	MAY	JUN	JUL	2. AUG	SEP	OCT

1. Spray stumps with lindane to control adults emerging after overwintering.
2. Spray trees to control feeding adults.

### Northern pitch twig moth (pitch nodule maker)

No pesticide treatment recommended.

### Pales weevil

bendiocarb      lindane  
carbofuran      phosmet

DORM.	1. APR	MAY	JUN	JUL	2. AUG	SEP	OCT

1. Spray stumps with lindane to control adults emerging after overwintering.
2. Spray trees with any of the above chemicals to control feeding adults.

### Pine bark aphid

demeton      insecticidal soap  
dimethoate      lindane  
dormant oil      malathion  
endosulfan      superior oil

1. DORM.	APR	2. MAY	JUN	JUL	AUG	SEP	OCT

1. Use dormant or superior oil.
2. Use other chemical pesticides.

### Pine chafer (Anomala beetle)

carbaryl      malathion  
diazinon

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT

### Pine grosbeak

No pesticide treatment recommended.

**Pine needle rust** (To control alternate hosts of pine needle rust, see weeds, broad-leaved.)

### Pine needle scale

acephate      ethion & oil  
carbaryl      insecticidal soap  
chlorpyrifos      malathion  
diazinon      oxydemeton-methyl  
dormant oil      superior oil

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT

### Pine root collar weevil

lindane      naled

DORM.	APR	1. MAY	JUN	JUL	AUG	2. SEP	OCT

1. To control adults emerging after overwintering.
2. To control this year's new adults.

### Pine root tip weevil

diazinon      naled  
lindane

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT

### Pine spittlebug

carbaryl      lindane  
chlorpyrifos      malathion  
Dymet      naled

DORM.	APR	1. MAY	JUN	2. JUL	AUG	SEP	OCT

1. To control nymphs.
2. To control adults.

### Pine thrips

acephate      malathion  
carbaryl      methoxychlor  
chlorpyrifos      naled  
demeton      oxydemeton-methyl  
disulfoton      trichlorfon  
lindane

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT

NOTE: Application time varies with weather, geographic location, chemical formulation, and insect and disease development. Check with a local pest specialist for proper timing, and read label carefully before using pesticide.



### Pine tortoise scale

acephate  
carbaryl  
diazinon

dormant oil  
malathion

1. DORM.	APR	MAY	JUN	2. JUL	AUG	SEP	OCT		

1. Use dormant oils during this period.
2. Use other chemical pesticides during this period.

### Pine tube moth

Dymet

DORM.	APR	1. MAY	JUN	2. JUL	AUG	SEP	OCT		

1. To control first generation.
2. To control second generation.

### Pine tussock moth

acephate  
*Bacillus thuringiensis* (Bt)\*  
carbaryl

insecticidal soap  
methoxychlor  
naled

\*A biological control agent.

DORM.	1. APR	MAY	JUN	JUL	2. AUG	SEP	OCT		

1. To control larvae emerging from overwintering.
2. To control this year's new larvae.

### Pine wood nematode

No pesticide treatment recommended.

### Pitch nodule maker (northern pitch twig moth)

No pesticide treatment recommended.

### Pocket gopher

Baits:

phorazetin  
sodium nitrate

strychnine  
zinc

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT		

### Rabbit and hare

Repellents:

capsaicin

thiram

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT		

Rabbit and hare damage is most likely to occur during the winter.

### Redheaded pine sawfly

acephate  
carbaryl  
Dymet  
insecticidal soap

malathion  
monocrotophos  
virus preparation\*

\*A biological control agent

#### Lake States

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT		

#### Central States

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT		

There are two overlapping generations in the Central States.

### Rhabdocline needlecast

chlorothalonil

maneb

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT		

Spray at bud break.

### Rhizosphaera needlecast

chlorothalonil

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT		

### Saratoga spittlebug

carbaryl  
chlorpyrifos  
Dymet

lindane  
malathion  
naled

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT		

To control alternate hosts of Saratoga spittlebug, see weeds, broad-leaved.

**Sawflies** (See redheaded pine sawfly, European pine sawfly, balsam fir sawfly or introduced pine sawfly.)

### Scleroderris canker

No pesticide treatment is recommended for plantations because of high cost, however, Chlorothalonil may be cost effective in nurseries.

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT		

### Shoestring root rot (*Armillaria*)

No pesticide treatment recommended.

**Shoot blight** (See *Diplodia* shoot blight and canker.)

**Soft scales** (See pine tortoise scale or spruce bud scale.)

**Spotted pine aphid** (See aphids.)

### Spruce budworm

acephate  
*Bacillus thuringiensis* (Bt)\*  
carbaryl  
endosulfan

insecticidal soap  
malathion  
naled  
trichlorfon

\*A biological control agent.

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT		

### Spruce bud scale

acephate  
carbaryl  
diazinon

dormant oil  
malathion

1. DORM.	APR	MAY	JUN	2. JUL	AUG	SEP	OCT		

1. Use dormant oils during this period.
2. Use other chemical pesticides during this period.

NOTE: Application time varies with weather, geographic location, chemical formulation, and insect and disease development. Check with a local pest specialist for proper timing, and read label carefully before using pesticide.

### Spruce needle rust

No pesticide treatment recommended.

### Spruce needleminers

acephate

carbaryl

DORM.	1. APR	2. MAY	JUN	3. JUL	AUG	SEP	OCT		

1. To control larvae emerging from overwintering.
2. To control new-generation larvae (Central States).
3. To control new-generation larvae (Lake States).

### Spruce spider mite

acephate

Dymet

azinphos-methyl

insecticidal soap

chlorpyrifos

malathion

demeton

monocrotophos

dicofol

naled

disulfoton

oxydemeton-methyl

dormant oil

superior oil

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT		

### Swiss needlecast

chlorothalonil

maneb

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT		

Apply first spray when new shoot is 1-1/2 in. long.

**Tip moths** (See Adana tip moth or Nantucket pine tip moth.)

### Webworms

*Bacillus thuringiensis* (Bt)\* Dymet

carbaryl

methoxychlor

diazinon

trichlorfon

\*A biological control agent

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT		

Treat as soon as you notice larvae.

### Weeds, broad-leaved

2, 4-D

picloram

glyphosate

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT		

Application time varies with chemical. Check label carefully to avoid damaging Christmas trees.

### Weeds, grass

amitrol

glyphosate

atrazine

hexazinone

dalapon

simazine

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT		

Application time varies with chemical. Check label carefully to avoid damaging Christmas trees.

### White grubs

diazinon

dursban

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT		

**White pine blister rust** (See weeds, broad-leaved to control alternate hosts.)

### White pine weevil

bendiocarb

oxydemeton-methyl

lindane

1. DORM.	APR	MAY	JUN	JUL	2. AUG	SEP	OCT		

1. To control egg-laying adults.
2. To control adults emerging from woody chip cocoons.

### Wood borers and bark beetles

No pesticide treatment recommended.

### Yellow-bellied sapsucker

No pesticide treatment recommended.

### Zimmerman pine moth

dimethoate

lindane

Dymet

naled

endosulfan

trichlorfon

DORM.	APR	MAY	JUN	JUL	AUG	SEP	OCT		

NOTE: Application time varies with weather, geographic location, chemical formulation, and insect and disease development. Check with a local pest specialist for proper timing, and read label carefully before using pesticide.



## Pesticide Common Name/Trade Name Cross-Reference



Common Name	Trade Names
<b>Insecticides</b>	
acephate	Orthene
azinphos-methyl	Azinphos-methyl, Guthion
<i>Bacillus thuringiensis</i> (Bt)	Dipel, Thuricide, Bactur
carbaryl	Sevin
carbophenothion	Trithion
chlorpyrifos	Dursban
demeton	Systox
diazinon	Diazinon, Spectracide
dicofol	Kelthane
dimethoate	Cygon, De-fend, Rebelate
disulfoton	Di-syston
Dymet	Dymet
endosulfan	Eudosulfan, Thiodan
ethion	Ethion
fenthion	Baytex, Entex
lindane	Borer spray, Isotox, Lindane
malathion	Cythion, Malathion
methomyl	Lannate
methoxychlor	Marlate, Methoxychlor
monocrotophos	Azodrin
naled	Bio-sec, Dibrom
oxydemeton-methyl	Metasystox-R
petroleum derivatives	Dormant oils, Petroleum oils, summer oils, Superior oils, Volck oils, White oils
phorate	Thimet
phosmet	Imidan
trichlorfon	Dylox, Proxol
<b>Fungicides</b>	
benomyl	Benlate, Benomyl
captan	Captan, Orthocide
chlorothalonil	Daconil, Bravo
ferbam	Carbamate, Ferbam, Vancide FE-95
maneb	Maneb Dithane M-22, Dithane M-45, Manzate
zineb	Dithane Z-78, Zineb
ziram	Vancide MZ-96
<b>Herbicides</b>	
2,4-D	2,4-D, Amoxone, Dacamine, DMA-4, Esteron, Formula 40, Verton, Weedar-64, Weedone
amitrole	Amitrol
atrazine	Aatrex, Atrazine
dalapon	Dowpon
glyphosate	Roundup
picloram	Tordon
simazine	Simazine, Princep
<b>Animal Repellents and Rodenticides</b>	
bone tar oil	Magic Circle Repellents, Bone oil
capsaicin	Hot Sauce Animal Repellent
strychnine	Certox, Mouse-Nots, Mole Death, Kilmice, Rat-Nots
warfarin	Certox, d-Con
thiram	Arasan 42-S
zinc phosphide	Certox, Kilrat

## Pesticide Precautionary Statement

Pesticides used improperly can be injurious to man, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers under lock and key—out of the reach of children and animals—and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first-aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary land-fill dump, or crush and bury them in a level, isolated place.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State or local regulations. Also, because registrations of pesticides are under constant review by the Federal Environmental Protection Agency, consult your county agricultural agent or State extension specialist to be sure the intended use is still registered.

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## Index of Common and Scientific Names



	Common Name	Scientific Name
Hazard-rating systems in forest insect management: Symposium proceedings; 1980 July 31-August 1; Athens, GA. Gen. Tech. Rep. WO-27. Washington, DC: U.S. Department of Agriculture, Forest Service; 1981: 93-98.	<b>Pests</b>	
	Adana tip moth	<i>Rhyacionia adana</i> Heinrich
<b>Scleroderris Canker</b> Skilling, D. D.; O'Brien, J. T. How to identify scleroderris canker. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1979. 6 p.	Allegheny mound ant	<i>Formica exsectoides</i> Forel
	Armillaria root rot	<i>Armillaria mellea</i> (Vahl ex Fr.) Kummer
Skilling, D. D.; O'Brien, J. T.; Beil, J. A. Scleroderris canker of northern conifers. For. Insect and Dis. Leaflet 130. Washington, DC: U.S. Department of Agriculture, Forest Service; 1979. 7 p.	bagworm	<i>Thyridopteryx ephemeraeformis</i> (Haworth)
	balsam gall midge	<i>Paradiplosis tumifex</i> Gagné
<b>Spruce Budworm</b> Montgomery, Bruce A.; Witter, John A.; Simmons, Gary A.; Rogan, Randall F. The spruce budworm manual for the Lake States. Tech. Man. 82-6. East Lansing, MI: Michigan Cooperative Forest Pest Management Program; 1982. 66 p.	brown spot needle blight	<i>Scirrhia acicola</i> (Dearn.) Siggers
	cedar-apple rust	<i>Gymnosporangium juniperi-virginianae</i> Schw.
<b>Swiss Needlecast</b> Skilling, D. D. Control of Swiss needlecast in douglas-fir Christmas trees. Am. Christmas Tree J. 25: 34-37; 1981.	Cooley spruce gall aphid (adelgid)	<i>Adelges cooleyi</i> (Gillette)
	Cytospora canker	<i>Cytospora kunzei</i> Sacc., also <i>Valsa kunzei</i> Fr. var. <i>piceae</i> Waterm.
Morton, H. L.; Patton, R. F. Swiss needlecast of douglas-fir in the Lake States. Plant. Dis. Rep. 54: 612-616; 1970. See "Rhabdocline Needlecast" citation.	deer	<i>Odocoileus virginianus</i> Miller
	Diplodia shoot blight and canker	<i>Diplodia pinea</i> (Desm.) Kickx.
<b>White Pine Blister Rust</b> Nicholls, Thomas H.; Anderson, Robert L. How to identify white pine blister rust and remove cankers. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1977. 8 p.	Dothistroma needlecast	<i>Dothistroma pini</i> Hulbary, also <i>Scirrhia pini</i> Funk & Park
	eastern pine shoot borer	<i>Eucosma gloriola</i> Heinrich
<b>White Pine Weevil</b> Marty, R.; Mott, D. G. Evaluating and scheduling white pine weevil control in the Northeast. Res. Pap. NE-19. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1964. 56 p.	eastern spruce gall aphid (adelgid)	<i>Adelges abietis</i> (Linnaeus)
	eriphyid mites	<i>Setoptus</i> sp.
<b>gall rusts</b>	European pine sawfly	<i>Neodiprion sertifer</i> (Geoffroy)
	European pine shoot moth	<i>Rhyacionia buoliana</i> (Denis & Schiffermüller)
<b>grasshoppers</b>	gypsy moth	<i>Cronartium</i> spp., <i>Endocronartium harknessii</i> (J. P. Moore) T. Hirat
	hare, snowshoe	<i>Melanoplus</i> spp.
<b>introduced pine sawfly</b>	jack pine budworm	<i>Epinotia nanana</i> (Treitschke)
	juniper webworm	<i>Lymantria dispar</i> (Linnaeus)
<b>Lophodermium needlecast</b>	meadow spittlebug	<i>Lepus americanus</i> Erxleben
	mouse (meadow vole)	<i>Diprion similis</i> (Hartig)
<b>Naemacyclus needlecast</b>	Nantucket pine tip moth	<i>Choristoneura pinus</i> Freeman
	northern pine weevil	<i>Dichomeris marginella</i> (Fabricius)
<b>northern pitch twig moth</b>	pales weevil	<i>Lophodermium seditiosum</i> Minter, Staley, & Millar
	pine bark aphid (adelgid)	<i>Philaenus spumarius</i> (Linnaeus)
<b>pine chafer (Anomala beetle)</b>	pine false webworm	<i>Microtus pennsylvanicus</i> (Ord)
	pine grosbeak	<i>Naemacyclus minor</i> Butin
<b>pine needle rust</b>	pine needle scale	<i>Rhyacionia frustrana</i> (Comstock)
	pine root collar weevil	<i>Pissodes approximatus</i> Hopkins
<b>pine root tip weevil</b>	pine tussock moth	<i>Petrova albicapitana</i> (Busck)
		<i>Hylobius pales</i> (Herbst)
<b>pine spittlebug</b>		<i>Pineus strobi</i> (Hartig)
		<i>Anomala oblivia</i> Horn
<b>pine thrips</b>		<i>Acantholyda erythrocephala</i> (Linnaeus)
		<i>Pinicola emicleator leucura</i> (müller)
<b>pine tortoise scale</b>		<i>Coleosporium asterum</i> (Diet.) Syd.
		<i>Chionaspis pinifoliae</i> (Fitch)
<b>pine tube moth</b>		<i>Hylobius radialis</i> (Buchanan)
		<i>Hylobius rhizophagus</i> Millers, Benjamin, & Warner
<b>pine tussock moth</b>		<i>Aphrophora parallela</i> (Say)
		<i>Gnophothrips</i> sp.
		<i>Toumeyella parvicornis</i> (Cockerell)
		<i>Argyrotaenia pinatubana</i> (Kearfott)
		<i>Dasychira pinicola</i> (Dyar)



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pine webworm	<i>Tetralopha robustella</i> Zeller
pine wood nematode	<i>Bursaphelenchus xylophilus</i> (Steiner & Buhrer) Nickle
pocket gopher	<i>Geomys bursarius</i> (Shaw)
rabbit, cottontail	<i>Sylvilagus floridanus</i> (J.A. Allen)
redheaded pine sawfly	<i>Neodiprion lecontei</i> (Fitch)
Rhabdocline needlecast	<i>Rhabdocline psuedotsugae</i> Syd.
Rhizosphaera needlecast	<i>Rhizosphaera kalkhoffii</i> Bud.
Saratoga spittlebug	<i>Aphrophora saratogensis</i> (Fitch)
scleroderris canker	<i>Gremmeniella abietina</i> (Lagert.) Morelet, also <i>Scleroderris lagerbergii</i> Gremmen
spotted pine aphid	<i>Eulachnus agilis</i> (Kaltenbach)
spruce bud scale	<i>Physokermes piceae</i> (Schrank)
spruce budworm	<i>Choristoneura fumiferana</i> (Clemens)
spruce needleminer	<i>Endothenia albolineana</i> (Kearfott)
spruce needle rusts	<i>Chrysomyxa</i> spp.
spruce spider mite	<i>Oligonychus ununguis</i> (Jacobi)
Swiss needlecast	<i>Phaeocryptopus gäumanni</i> (Rohde) Petrak
white grubs	<i>Phyllophaga</i> spp.
white pine aphid	<i>Cinara strobi</i> (Fitch)
white pine blister rust	<i>Cronartium ribicola</i> Fisher ex. Rabenh.
white pine weevil	<i>Pissodes strobi</i> (Peck)
wood borers and bark beetles	<i>Ips</i> spp., <i>Monochamus</i> spp., etc.
yellow-bellied sapsucker	<i>Sphrapicus varius</i> Linnaeus
Zimmerman pine moth	<i>Dioryctria zimmermani</i> (Grote)

### **Trees**

Austrian pine	<i>Pinus nigra</i> Arnold
balsam fir	<i>Abies balsamea</i> (L.) Mill.
Black Hills spruce	<i>Picea glauca</i> (Moench) Voss
black spruce	<i>Picea mariana</i> (Mill.) B.S.P.
Colorado blue spruce	<i>Picea pungens</i> Engelm.
Douglas-fir	<i>Pseudotsuga menziesii</i> (Mirb.) Franco.
eastern redcedar	<i>Juniperus virginiana</i> L.
eastern white pine	<i>Pinus strobus</i> L.
Fraser fir	<i>Abies fraseri</i> (Pursh) Poir.
Norway spruce	<i>Picea abies</i> (L.) Karst.
red pine	<i>Pinus resinosa</i> Ait.
Scotch pine	<i>Pinus sylvestris</i> L.
Virginia pine	<i>Pinus virginiana</i> Mill.
white fir	<i>Abies concolor</i> (Gord. & Glend.) Lindl. ex Hildebr.
white spruce	<i>Picea glauca</i> (Moench) Voss

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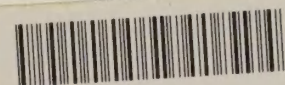
U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. Christmas tree pest manual. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1983. 108 p.

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KEYWORDS: Insects, diseases, degrade, pest management, cultural control, pesticides, monitoring.

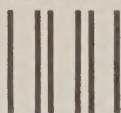
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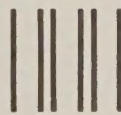
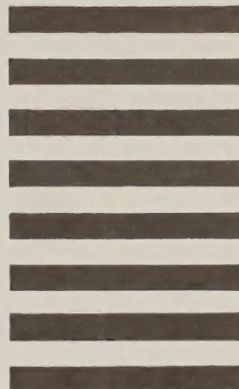
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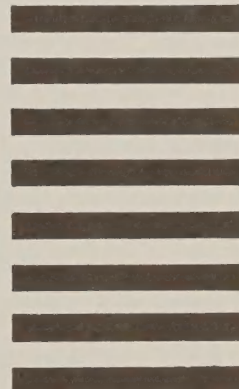
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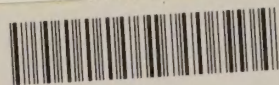
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